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TORONTO

# SOYBEANS

## *Gold from the Soil*

REVISED EDITION

BY  
EDWARD JEROME DIES

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1943

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# **S O Y B E A N S**

**Gold from the Soil**

## CHAPTER I

### A CERTAIN MAN OF SCIENCE

"Oh, that man?" said the moon-faced oriental. "He's the crazy American. For many months he has been here in North China, wandering through our fields from dawn to dusk. He pulls up soya plants and stares long at them."

Here he smiled and lowered his voice: "They say he was sent by his government. It is so amusing. The miracle bean has been a part of our life for ages. Suddenly it is discovered by Americans. Such queer people!"

But the crazy American, tall, lean William Joseph Morse, his slouch hat and baggy clothes limp under rain and sun, went right on plodding through the fields of North China, then across Japan and Korea and Manchuria. For two solid years he tramped the wide productive stretches, scrutinizing roots, foliage and seeds, testing type after type, and ended the long trek only when he had assembled five thousand distinct samples of seed, representing some two thousand varieties. Contented at last with his gleanings, the agricultural explorer returned to America to give the soybean industry another powerful push.

It was on the morning of June 20, 1907 that young Bill Morse was handed his degree at Cornell University. This happened to be the year of the "Rich Man's Panic." Times were unpropitious for college boys launching out into business and professions. But Bill Morse had been the kind of student professors discuss with visitors in low voices. Two

days after receiving his degree he reported for duty at the Bureau of Plant Industry in Washington where he was assigned work under the late Dr. C. V. Piper, a man of intense enthusiasm and vision, a plant scientist of superior talent. Young Morse was placed in charge of forage crop investigations at Arlington Experimental Farm in Virginia where a dozen or so distinct types were being nurtured, and Dr. Piper became his constant companion there on Sundays, evenings and at other odd times, talking, dreaming, painting word pictures of a future agricultural economy in which the little bean would play a tremendous role.

"Young fellow," he used to say, "these beans are gold from the soil. Yes, sir, gold from the soil. One must truly stand in awe of their potential power in the life of the western world."

In some strange way Dr. Piper seems to have turned a switch in the heart of young Morse and created there a strong desire to see through to the final act the colorful and exciting drama of the soybean.

And so for thirty-four years, heedless of material gain or personal honor, shy, modest, but with the repressed intensity of a crusader, Bill Morse has carried with steady hand the lamp lighted by Dr. Piper. By the irony of fate Piper the Prophet passed away without tasting the joy of full success that came from their joint labors.

In the early years the tide of interest ebbed and flowed; doubters were ever present to dash cold water upon any spark of enthusiasm, to brush aside the oriental product as a curiosity, to slap each other on the back and laugh at talk of the bean becoming a major crop; to them it was a colossal joke, a bit of drollery, this gab about a little bean. All of which served to spur Bill Morse to greater efforts;

neither his father, John Baptist Morse, nor any of his other kinsfolk around Lowville, New York, where he was born in 1884, had ever ducked a hard job. He determined to carry through.

He began writing factual articles on the plant; he started talking with farmers and to other scientists; he made a journey through the South as early as 1914, when soybeans were grown principally in eastern North Carolina, to study the feasibility of cottonseed mills launching a soybean crushing industry, and found the time too early.

But the army of Morse disciples grew, his desk at the Forage Crops division became an official clearing house of information, and in 1919 there was formed the American Soybean Association and Bill Morse served as president for three terms, helping to unify and direct a new and more forceful crusade of research and experimentation. He wrote and published more than forty official government bulletins, made hundreds of addresses, inspired scores of agrarians, research experts, plant scientists and industrialists to new endeavors, and brought in from distant lands more than ten thousand samples of soybeans, including those gathered in the two years (1929-31) as an agricultural explorer for the government.

So the work of Bill Morse, the agreeable, easy-going Senior Agronomist, runs like a bright thread through the whole tapestry of soybean development in the western world.

In 1929: America grew nine million bushels of the miracle bean.

In 1939: America grew ninety-one million bushels.

As the vast garden sprawled farther and farther across fertile lands of the Midwest the prophecy of one man and

the dreams of two men began to take form and substance.

Bill Morse would be first to cry out against any implication that credit for the amazing development be given to one or two men. True, he has only lighted the way with indomitable courage and persistence. There have been many helpers—the brilliant Burlison, the persistent, thorough Hackleman of the University of Illinois, Woodworth of Illinois, Beeson and Ostrander of Indiana, Delwiche and Briggs of Wisconsin, Wilkins of Iowa, Park of Ohio, Wiggins of Cornell, and Williams of North Carolina—all top-flight in their respective fields, and Barr of the Department of Agriculture with his research in commercial grades.

Then there were the real pioneers among the growers—in Illinois, John T. Smith and W. E. Riegel; in Ohio, Elmer and E. F. (Soybean) Johnson and G. G. McIlroy; in Indiana, J. B. Edmondson, the three Fout brothers, and the late Charles Meharry, charming, lovable enthusiast who sometimes stirred fires that had begun dying out at the universities. All were close friends and co-workers of such early processors as I. Clark Bradley, the late A. E. Staley, whose life story is so closely associated with the soybean, and E. D. Funk.

All of them made their early contributions—important contributions—to the birth of a new industry, a hundred million dollar annual industry that has changed the Midwest landscape, an industry built upon a simple little oriental bean that now moves to the marts of trade in wagons, trucks, trains and steamboats, and that sends a steady stream of dollars into the pockets of the American farmer.

Prophet Piper dreamed the dream and saw the miracle bean as “gold from the soil.”

Crusader Morse helped make the dream come true.

# Gold from the Soil

## SOYBEAN ACREAGE AND PRODUCTION, 1924-41

### UNITED STATES CROP SOYBEANS FOR BEANS

CROP YEAR*	ACREAGE	YIELD PER ACRE	PRODUCTION BU.
1924	448,000	11.0	4,947,000
1925	415,000	11.7	4,875,000
1926	466,000	11.2	5,239,000
1927	568,000	12.2	6,938,000
1928	579,000	13.6	7,880,000
1929	708,000	13.3	9,398,000
1930	1,008,000	13.4	13,471,000
1931	1,104,000	15.2	16,733,000
1932	977,000	15.3	14,975,000
1933	997,000	13.2	13,147,000
1934	1,539,000	15.0	23,095,000
1935	2,697,000	16.5	44,378,000
1936	2,132,000	14.1	29,983,000
1937	2,549,000	17.8	45,272,000
1938	3,105,000	20.2	62,729,000
1939	4,417,000	20.7	91,272,000
1940	4,779,000	16.1	77,374,000
1941	5,855,000	18.9	106,712,000

\* Oct. 1-Sept. 30.

Total production from the 1942 crop was shown in the U. S. crop report of Nov. 1, 1942, as 209,953,000 bushels.

SOURCE: Crops and Markets, U.S.D.A.

III. Crop Statistics, Circular 440-441.

Latest government reports.

VIGNETTE FROM ANTIQUITY

Even when the Pyramids were being built, three hundred years before the Tower of Babel, and twelve centuries before Solomon fashioned his temple, the soybean was hoary with age. The earliest writings on the subject go back to the period of the Pyramids.

But of the science of soybean growing you will find no recorded beginnings in the musty tones of oriental history. No book reveals the name of the first inquisitive oriental who in the misty long ago began sowing the seeds, harvesting the beans, pounding them into a mash for cooking and eating, and probably boring his friends no end with tales of their merit. There is no record depicting this unsung hero's foresight in saving the seed of the magic plant against next year's hunger. Likely as not he was a crude dreamer who fumbled his hunches and accomplished little in a lifetime of wrestling with the problem of proper cultivation.

Oriental literature of a later date contains much about the plant but of its origin as a food product again there are only legends.

A choice vignette from antiquity on the initial use of soybeans runs something in this fashion. Long, long ago, far back in the dim past, a caravan pulled out of an eastern China town. It consisted of a number of merchants and their servants. It left with many farewells just as a red

sun was dipping below the rim of the world. The caravan was bound for a distant inland settlement intent upon disposing of its valuable wares. The journey was without mishap, so the story goes, and after a gay visit with their northern friends, the merchants turned their camels to the southeast and the long line moved across the wastes on the homeward trip, now laden with gold, silver and choice furs received in payment for the merchandise. Suddenly at dusk on a day when the caravan still was far from home it was surrounded by bandits who had learned of the rich prize at hand. Merchants and servants took quick refuge in a rocky defile easy of defense. Here they were besieged day on day until their scanty provisions ran low and starvation seemed inevitable. At length a servant whispered to his master and pointed to a vinelike plant bearing some sort of legume. No one could recall having seen such a plant before but all were touched with the pinch of hunger. So with grave doubts the hopeless men pounded the beans into a thick flour, mixed it with water, and made coarse cakes. Upon these cakes the caravan survived, and with renewed strength fought off the foe until help arrived. And, so the legend goes, from that day forth the miracle bean became the staff of life in China.

True or false, the story has lived through the ages.

For the first written record of the soybean one must turn to "Materia Medica," written by Emperor Shen-nung in 2838 B.C. It describes many plants of China including that of the soybean, but even the name is clouded with antiquity. In the early Chinese history the name "Shi-yu" and the name "Ta-tou" were applied to the soybean. These names probably antedate the first authoritative records of the plant.

To the early Chinese, the word "Shi" meant the salted bean and the word "yu" alluded to a condiment, and evidently the combination was applied to the plant as well as to the raw bean.

Of course the soybean was in actual use in the Orient for thousands of years before it found its way to the western world. It was introduced to Europe in 1712 by Engelbert Kaempfer, a German botanist who had spent the years 1691 and 1692 in Japan. But Europe was little stirred. Mild interest was born largely of curiosity. The first botanist to make a really scientific study of the leguminous plants was Linnaeus. He applied the Greek word "glycine," meaning sweet, to all the groundnut species of legumes. As the soybean had very large nodules on the roots he called it *Glycine Max*. Incidentally, botanical history of the soybean was confused owing to an early error by Linnaeus himself in the identification of the legume. In his first edition of "Specie Plantarum," 1753, he described two supposedly different plants, one being called *Phaseolus Max* and the second *Dolichos soja*. In time the error was corrected.

Years later Moench discovered the soybean was a distinct genus and so renamed it *Soja hispida*. More modern authorities have shown a preference for *Soja Max*, a name generally accepted.

By the turn of the nineteenth century leading plant scientists in most countries were familiar with the oriental legume, but showed no inclination to adapt it to domestic purposes. Then in 1804 a Yankee Clipper ship in full sail glided down the coast of China searching the ports for a return cargo. Not too sure of the length of the return journey, the captain ordered several bags of soybeans

tossed into the hold as a reserve food supply. And thus did the first soybeans enter America. Little was done about soybeans then.

James Mease of Pennsylvania first mentioned in American literature shortly after this importation that the soybean was adaptable to Pennsylvania and should be cultivated. Twenty-five years later a brown-seeded variety was shown in the Botanic Garden at Cambridge, Massachusetts, but only as a curiosity. Then in 1854 the Admiral Perry Expedition brought back two varieties of soybeans from Japan. People looked at them but were not excited.

In 1907, Dr. C. R. Ball of the United States Department of Agriculture described twenty-three varieties of soybeans, all that were then known in the United States. These included fifteen introductions by the United States Department of Agriculture between 1900 and 1905. The remaining eight were brought by individuals from the Orient, several by way of Europe.

A total of more than ten thousand samples of beans now has been collected from Japan, Korea, Manchuria, China, Formosa, Java, Sumatra, and India. Of this number, two thousand are distinct types. Maturity ranges from seventy-five to more than two hundred days. These types and varieties have been grown in various sections. The less promising have been discarded until at present more than a hundred named varieties are widely grown or are being increased for greater distribution in the United States.

There have been bloody clashes in the Orient over the soybean—class struggles, riots and rebellion. Local political parties have risen and fallen in this strife. Wars have been fought, and it is claimed by some authorities that Japan's attack on China was inspired in some mea

## SOYBEANS

Production in Specified Countries, and Estimated World Total, in  
Thousand Bushels, Excluding China \*

YEAR	ESTIMATED WORLD TOTAL EXCLUDING CHINA	CHINA	MAN- CHURIA	UNITED STATES	CHOSEN	JAPAN
1909						17,855
1910					13,017	16,100
1911					14,288	17,505
1912					17,237	16,644
1913					17,078	14,187
1914					17,177	17,370
1915					19,038	18,048
1916					20,029	17,774
1917					20,427	17,086
1918					23,075	16,359
1919					15,550	18,631
1920					22,710	20,241
1921					22,179	20,199
1922	163,000		113,469		21,404	17,244
1923	169,000		119,853		22,000	16,276
1924	158,000		112,055	4,947	18,723	15,367
1925	179,000		126,092	4,875	23,609	17,106
1926	156,000		107,740	5,239	22,276	14,213
1927	217,000		163,319	6,938	24,300	15,467
1928	227,000		177,804	7,880	19,510	14,110
1929	228,000		178,372	9,398	20,434	12,585
1930	256,000		196,949	13,471	22,989	14,381
1931	258,000	210,038	192,057	16,733	21,155	11,777
1932	217,000	240,685	156,816	14,975	22,578	11,435
1933	230,000	267,175	169,056	13,147	23,324	13,307
1934	186,000	207,400	122,973	23,095	19,519	10,255
1935	231,000	184,413	141,793	44,378	22,401	10,719
1936	226,000	217,192	152,375	29,983	17,937	12,485
1937	255,000	251,362	159,907	45,272	20,205	13,473
1938	278,000		170,268	62,729	18,333	
1939 <sup>d</sup>	285,000		149,435	91,272		
1940 <sup>a</sup>	266,700			77,374		
1941 <sup>d</sup>				106,712		

\* Data are not available for certain countries in years for which blank spaces are shown.

<sup>b</sup> Native crops only.

<sup>c</sup> Includes Poland, Czechoslovakia, and what was formerly Austria.

<sup>d</sup> Preliminary.

<sup>e</sup> Reported as production minus seed for planting.

SOYBEANS—*Continued*

NETHER- LANDS INDIA <sup>b</sup>	KWAN- TUNG	TAIWAN	U.S.S.R.	RUMANIA	BUL- GARIA	YUGO- SLAVIA	OTHER EUROPE <sup>c</sup>
	375						
	719						
	538						
	519						
	400						
2,603	566						
2,809	276						
2,523							
2,533							
3,740							
3,697		280					
3,787							
3,574							
3,531	716	220					
4,038	716	220					
3,608	716	220					
3,961	716	227					
4,303	735	197	2,060				
3,917	735	176	1,958				
4,692	735	175	3,060				
4,722	735	189	10,384				
5,471	735	173	4,383				55
6,669	841	171	3,884				60
6,445	816	152	2,504	26	77	26	49
7,448	764	139		424	634	36	60
9,090	650	162		1,366	179	22	
9,880		159		2,584	419	54	
9,873 <sup>c</sup>				1,901	246	140	
				2,572	827	213	

Bureau of Agricultural Economics. Data by countries compiled from official sources and the International Institute of Agriculture.

NOTE: Since the European war broke out there has been great difficulty in getting correct production figures from the various foreign countries.

prize of the immense soy crop which in the past decade has averaged about two hundred million bushels a year.

In the present World War the soybean is playing an important role. It constituted a material part of the ration of the huge German army in the first years of the War. While Hitler and Stalin were still "friends" the supply was siphoned from the Orient to Germany over the single-track railroad across the wastes of Siberia.

## CHAPTER 3

### BIRTH OF AN INDUSTRY

In the stream of agricultural history there are few events more exciting than the dizzy rise of the soybean in the United States. From 1922 through 1930 groundwork was laid for the really big expansion which, curiously, began in the depression years of the early 1930's when this surplus producing nation and its more than thirty-one million farmers were passing through a jittery period.

In 1932, for instance, wheat surpluses were being piled high through price pegging, while values of that grain here and in England touched the lowest point since the days of Queen Elizabeth. Cotton conditions were similar; and through such experimenting with the laws of supply and demand we lost permanently a substantial part of the long-valued foreign markets for important surplus crops.

The rise of the soybean industry is mirrored in the fact that production in the decade beginning in 1929 rose 700 per cent.

In the face of an over-abundance of feed and food crops, and despite tremendous competition from old-established products, this new crop was processed to the last bushel available and placed in consumptive channels at excellent profits to the farmers—a truly astonishing merchandising feat in light of prevailing conditions.

But processors had told the farmers: "You grow the beans. We'll buy them and expand the market." To date

they have kept that promise, pouring millions into expansion of facilities—expansion that has always exceeded needs, expansion that may have been too rapid judging from red figures decorating many a ledger.

Pounding the drums for the growing of soybeans had to be followed by assurance of a ready market. It was such definite, courageous, and at times costly, assurance that brought results.

It is only possible here to sketch in broad outline the inception and expansion of soybean processing.

The first soybeans processed in this country were imported from Manchuria in 1911 and sold to Herman Meyer who had a small crushing plant in Seattle, later called the Pacific Oil Mills. From the raw material he produced the two chief products—soybean oil meal for livestock feed and soybean oil, selling the latter locally for industrial use. The meal was advertised and sold as "Pro-teina," a high-protein feed. The venture did not last for any considerable period; a few years later Meyer passed away.

Soybeans grown in this country were processed first by the Elizabeth City Oil and Fertilizer Company at Elizabeth City, North Carolina. W. T. Culpepper, now postmaster at Elizabeth City, was manager of the new mill, started in 1912. The first domestic soybeans were crushed for commercial purposes there in the late fall of 1915. It was a small operation.

At that time most of the soybeans were grown in North Carolina, and the Winterville Cotton Oil Company at Winterville, North Carolina, purchased expellers for processing purposes, and these operated on soybeans for a limited period. Still another mill, operated by Havens Oil

Company at Washington, North Carolina, crushed thirty thousand bushels of beans as an experiment in 1916.

"My uncle, Jonathan Havens," says J. Havens Moss, "was the first to plant soybeans in this section, devoting considerable acreage to the mammoth yellow type which grew and matured splendidly from the very start. Its value to the land was obvious.

"The crude oil from the beans was shipped to refineries. The soybean oil meal was sold in the East and as far west as Chicago, a considerable amount going to Canada."

Possibly other cottonseed mills in that territory operated for brief periods on soybeans in those early days.

A general shortage of fats and oils during the first World War made it necessary to import large quantities of Manchurian soybean oil. Frequently this product was of poor quality due to crude equipment of manufacture. Often it was shipped from the Orient in five-gallon kerosene cans, improperly cleansed. The contaminated oil was unfit for edible purposes. We imported three hundred and thirty-six million pounds of soybean oil in 1918.

By the end of the war, the gospel of Bill Morse, Dr. W. L. Burlison and Professor J. C. Hackleman of the University of Illinois and the swelling group of other enthusiasts fell upon more receptive ears. In some districts it became popular to replace oats with soybeans on sour soils where clover would not grow. Then the search began for an outlet for the soybean crop if grown for seed production.

Out at Chicago Heights, Illinois, a mill was operating with hydraulic presses on linseed and an expeller plant crushing corn germs and mustard seed. It was the Chicago Heights Oil Manufacturing Company, operated by

George Brett in association with I. Clark Bradley, one of the ablest and best-known men in the industry, and now with Allied Mills, Inc.

This small plant was favorably located to serve Illinois and Indiana, and the suggestion was advanced that it engage in soybean processing and seek to gain a market for the oil and meal. But in the fall of 1919 came disappointment, for the farmers sold their crop for seed with the exception of a small amount which the mill used to determine methods of grinding and drying. The few drums of oil produced were as sorry-looking as the beans.

There was disappointment again the following year because once more the crop went for seed. So to carry out their plans Brett and Bradley bought ten carloads of mammoth yellow soybeans from North Carolina and Virginia. In the following winter the test was made and from these and other beans on hand four-tank cars of oil were produced and marketed through Otto Eisenschiml's oil compounding company. (Eisenschiml, incidentally, is the author of recent important works on Lincoln.)

Enough soybeans were accumulated in 1922 and 1923 to try out the hydraulic presses and evidence was established that both the expeller and hydraulic methods were satisfactory. More oil was produced and marketed through the same channel.

Plainly the first step in the development had been taken. But now a certain market for the oil and meal must be created. Potential oil buyers were cold to the domestic product, citing endless reasons. Possible users of the soybean oil meal doubted its value. Says Bradley:

"In the three years from 1920 we coaxed and forced feeders to try the meal. We hauled meal to them all over

the state, gave it to them free. We sent it to experiment stations. We exhibited it at state and county fairs; we made soybean flour and sent samples to bakers, had it blended at a flour mill with wheat flour, and gave five-pound bags to hundreds of grocery stores who would consent to accept it."

It became clear that better progress could be made if the seed business and the processing business could be combined so that a market might be extended to all classes of soybeans. The soybeans then either might be processed or sold for seed as requirements indicated. In light of this situation Eugene D. Funk, another in the group of early workers and head of Funk Bros. Seed Co., at Bloomington, Illinois, purchased the plant and incorporated it into the seed business in 1924 and Bradley continued his work at Bloomington.

Funk recognized the importance of a ready market for the farmers to whom he sold seed. Writing in the *Prairie Farmer* of January 11, 1941 he says:

"But before we merchandised our 1922 crop we were assured by the A. E. Staley Manufacturing Company of Decatur, Illinois, that they would complete installation of soybean mills that would provide a cash market for all of the beans grown from seed available that season. The next year we had a plant at Bloomington where we crush soybeans, extract oil and exchange soybean oil meal for beans with farmers as well as buy for cash. These plants were the vanguard of a tremendous industry."

By that time a better quality of soybean was available and through processing experience improved products were turned out. The problem of marketing the oil was less disturbing, but the soybean oil meal still was a drag.

In 1922 the Staley Company had entered the industry and is the oldest continuous soybean processor in business today. A few other small processing units had started up to explore the new field by 1924. None of them is in business today.

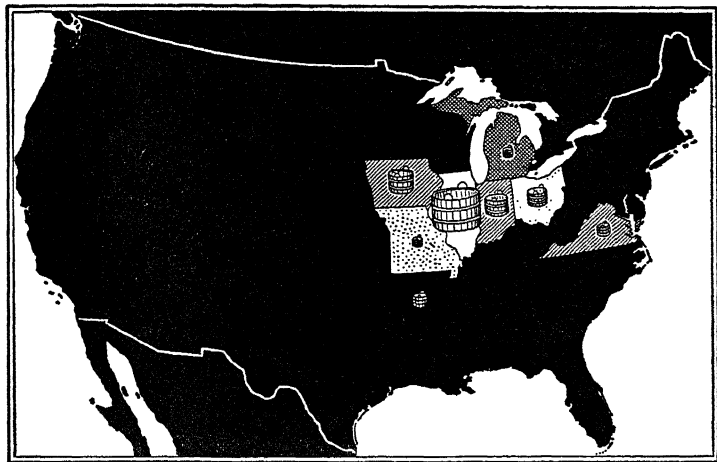
The quantity of soybeans procurable was very indefinite and products for customers likewise were indefinite. "Finally," says Bradley, "the whole picture was painted to the late H. G. Atwood, then president of the American Milling Company and subsequently head of Allied Mills, Inc. He immediately saw that the soybean deserved a chance in the feed industry. If the product was an aid to agriculture his organization would assist.

"He authorized the purchase of the soybean oil meal output of Funk and of several other mills. Here was the first real chance for the product, whose popularity since has risen to amazing heights, to gain a foothold in the field. It was another forward stride."

A new obstacle developed in the next two years. Farmers were reluctant to plant sufficient acreage of soybeans to insure expansion of processing. They felt the seed demand would materially decrease and that perhaps the price for commercial soybeans would dip below production costs.

It was at this juncture, says Bradley, that Atwood, the Grange League Federation, and Funk met with representatives of Farm Bureaus, with key farmers, and with men of the Illinois Agricultural College. They agreed to obligate themselves to purchase on contract in 1928 all the soybeans produced from fifty thousand acres at a stipulated price per bushel. . . . Production in 1928 totaled seven million eight hundred and eighty thousand bushels.

"Perhaps no one action taken in the early period had more telling effect," Bradley declares. "Similar procedure by this group and others continued until a fair degree of security was established for soybean growers, processors and buyers of meal and oil."

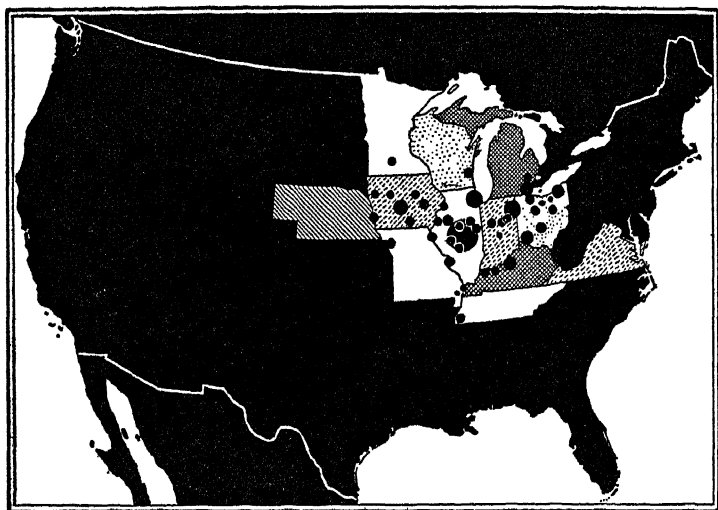


Almost 90 per cent of all soybeans are harvested in Illinois, Iowa, Indiana and Ohio. If three other states are included as shown on the map—Missouri, Michigan and Virginia—the total is 97 per cent. The size of the baskets is proportional to the volume produced.

An industry was born. Agronomists and agrarians had laid the groundwork, processors had followed through, risking millions on new machinery, equipment and facilities, and in subsequent years there has been perfect coordination of the interests of the federal and state agricultural departments, university workers, farm organizations, individual farmers and soybean processors. It is a striking

example of constructive cooperation between government and business.

The early life of the soybean industry in this country cannot be separated into parts, any more than you can separate a dynamo and continue its operation. Each factor was indispensable.



As Illinois produces about 52 per cent of the soybeans harvested for seed, central Illinois is the center of soybean processing as shown on this map. The discs indicate relative importance of processing centers. Total processing capacity in late 1942 exceeded 100 million bushels for the regularly established soybean processing plants. Southern cottonseed plants and some copra plants were being used as supplementary soybean processing equipment in 1943 to meet the war emergency in connection with shortage of vegetable oils.

## CHAPTER 4

### THE BIG DRIVE STARTS

New ideas of high merit are rarely put over with ease. It is not forgotten that the first railroad tracks were torn up. Pious people said, "God never intended His creatures to travel at the frightful speed of seventeen miles an hour." The first sewing machine was smashed, the first man to sell hard coal in Philadelphia was chased off as an impostor. When Seth Woodbury began using rubber tires on his buggy, the Common Council of Lynn, Massachusetts, stopped him because, "their silence endangered pedestrians." Virginia once taxed bathtubs.

People question change. Eli Whitney was snubbed by doubters. When he introduced his cotton gin the Southern States were in debt. Use of the gin brought the greatest prosperity they had known. So it has gone.

Many curious tales could be told of early opposition to the two major soy products—meal and oil—in the present enlightened age. But such stories would serve only to redden the faces of many present-day consumers. They are better left untold. In his later years Staley used to get many a chuckle from some of these recollections, but there was nothing funny about them in the early battle for a place for soybean products in the commercial sun.

In the soybean's struggle for recognition the severe test came when the industry moved from the period of preliminary introduction into the phase of mass production,

with its immense merchandising problems. In this sphere we find two companies—the A. E. Staley Manufacturing Company, which began crushing in 1922, and the Archer-Daniels-Midland Company, which began in 1929—as huge-scale producers with the expansion of the crop, followed by Central Soya Company, Inc., which began in 1934, and Spencer Kellogg and Sons, Inc., which began in 1935.

The Staley plant operated seventy-four days on twenty-six thousand two hundred and thirteen bushels of soybeans in 1922. Five years later, although mills were grinding slowly, the crush had risen to one hundred and sixty-five thousand five hundred and seventy-three bushels, a substantial volume for that period of difficulty in getting farmers to grow commercial beans. But Staley lived to see the operation rise to giant proportions and to see Decatur acquire the sobriquet of Soybean Capital through enlargement there of his own firm, of Archer-Daniels-Midland Company and of Spencer Kellogg and Sons, Inc. Decatur Soy Products Company also has a small plant at Decatur. Staley died on December 26, 1940 at the age of seventy-three. In the past several years he had retained the position of chairman of the board, placing active executive management with his son, A. E. Staley, Jr., president. E. K. Scheiter, associated with Staley from the beginning of his soybean operation, has charge of the company's soybean business both at Decatur and at Painesville, Ohio.

Gene Staley, as he was known to thousands of agrarians, was indeed a powerful factor in the industry's development. He used to quote Hawthorne, "The world owes all its onward impulses to men ill at ease." He himself was

ill at ease from the time he began fighting for the soybean until the dreams of Piper the Prophet and the early crusades of Bill Morse and others had begun to bear fruit.

He was born and grew up on a red clay farm in North Carolina. The story is told that when he was seven years old a missionary gave him a few seeds.

"Soybeans from China, my lad. They are fine food for man and beast," the missionary said. "Plant them and see what happens." He did, they grew, and for a time soy was added to the family diet.

Disliking farm life as a young man, Gene Staley went on the road selling food products, including starch, and by 1912 he had begun making his own starch from a corn plant at Decatur.

With a shoestring capital of fifteen hundred dollars and the magic of his commercial genius, he built one of the largest corn refining businesses in the country. When he extolled the merits of the soybean, as he did almost constantly, central Illinois farmers knew he meant business. Had he not bought from ten to fifteen million bushels of their corn each year and processed it at Decatur? It was his years of background in merchandising corn-gluten feed that impressed buyers when later he pleaded the case of soybean oil meal as a part of their protein concentrate.

Six years before he began processing, Gene Staley, a giant of a fellow, a natural mixer gifted with a memory for names and faces, had won the confidence of many farmers. Before launching his processing plant he had observed closely the early experimental work of Bradley and others and set out to add improvements. Illinois land had been "corned" to death during the war. Farmers were

more receptive to the soy, but to increase production they still must have a greatly enlarged market. They had raised the plants for hay and forage and fertilizer, and could see no hope for the beans except as seed until processing developed on a broader scale. Their position was crystal clear to Gene Staley. So coincidentally with launching his soy plant he intensified the drive for bigger acreage, using salesmen, speakers and exhibits, flooding certain Illinois sections with bulletins and pamphlets stressing best methods of production. He recognized four basic problems: Inducing the farmer to raise the variety affording largest yield consistent with high quality and oil content; an attractive price, compared with other standard crops; manufacture of products equal or superior to competitive products; and mass production operations aimed toward low cost of products. He bent every effort to solve these problems.

His insistence upon research carried his company into the development and manufacture of refined soybean oil for edible purposes, soy flour for human consumption, and a wide range of high protein feeds for scientific animal nutrition.

In the eight years beginning in 1922 Staley and other early processors developed procedures that made maximum production operations feasible. In those years the quality of soybean oil meal for animal nutrition was so improved in palatability and digestibility as to acquire widespread acceptance. The higher quality meal and oil helped lift returns to the farmer, and the growing and processing of soybeans came into the range of economic competition with other deeply entrenched oil meals and oils.

ILLINOIS ACREAGE AND PRODUCTION, 1919-41  
SOYBEANS FOR BEANS

CROP YEAR*	ACREAGE HARVESTED FOR BEANS	YIELD PER ACRE Bu.	PRODUCTION Bu.
1919	3,000	10.0	30,000
1920	4,000	11.5	46,000
1921	17,000	9.8	167,000
1922	65,000	12.5	812,000
1923	92,000	14.0	1,288,000
1924	115,000	12.0	1,380,000
1925	106,000	13.5	1,431,000
1926	140,000	12.5	1,750,000
1927	184,000	13.0	2,392,000
1928	186,000	16.5	3,069,000
1929	226,000	17.0	3,842,000
1930	410,000	17.0	6,970,000
1931	428,000	18.0	7,704,000
1932	388,000	20.0	7,760,000
1933	361,000	15.0	5,415,000
1934	724,000	19.0	13,756,000
1935	1,334,000	18.0	24,012,000
1936	1,076,000	16.0	17,216,000
1937	1,352,000	20.0	27,040,000
1938	1,452,000	23.5	34,122,000
1939	1,911,000	24.5	46,820,000
1940	1,995,000	17.5	34,912,000
1941	2,285,000	21.5	49,128,000

\* Oct. 1-Sept. 30.

SOURCE: Ill. Dept. of Agriculture.

Production in Illinois in 1921 was one hundred and sixty-seven thousand bushels, in 1922 it was eight hundred and twelve thousand bushels, in 1923 it rose to one million two hundred and eighty-eight thousand and in 1924 the total was one million three hundred and eighty thousand bushels. The unified drive of all interests began to show genuine promise.

Only once in his soybean career did Gene Staley sound a note of pessimism. Answering an inquiry from West Virginia in May, 1924, he wrote:

"The result of our experience so far has been both unprofitable and discouraging. But it is our intention to leave the machinery in our plant for another year and if production and manufacture are not more profitable . . . it will then be our intention to dismantle our plant and discontinue the soybean business. Last year . . . when we consider investment, depreciation of machinery, and plant idleness the business was a loss.

"This year other manufacturers entered the market and prices were bid up so high to secure enough soybeans to keep plants running that the business showed a severe loss. Our loss for one month's operation amounted to approximately twelve thousand dollars.

"Soybean oil meal is an unknown feeding product and is difficult to sell. Manufacturers of livestock feed must be persuaded to use it in their formulas. Many questions are involved, including the cost of changing registration on all their products in the various states. There is a limited demand for soybean oil and this market must be developed to sell even a small quantity."

It was not an easy road, not a path for tender feet. It took courage to go on. But in 1925 operations were more successful and still greater push was put behind the sales drive, and posters and hangers began decorating stores, elevators and banks, offering free literature and advice on growing.

The American Soybean Association started holding meetings. State departments of agriculture issued new literature, universities increased the work of experimenting

with soy cultivation, farm machinery manufacturers and railroads added their efforts to the campaign for expansion. While in 1925 Illinois, the heart of soy cultivation, threshed one million four hundred and thirty-one thousand bushels, in 1928 the total was three million and sixty-nine thousand bushels, and in 1935 it rose to twenty-four million and twelve thousand bushels. By reason of educational work among the farmers the yield per acre increased in a decade from 13.5 bushels in 1925 to 18.0 in 1935. Meanwhile as the years passed new processing mills began to dot the soy belt.

Back in 1926 the William O. Goodrich Company (acquired by Archer-Daniels-Midland Company in 1928) was experimenting with the solvent extraction of soybeans and other vegetable oil seeds, using a Scott Batch extraction system. In 1933 Shreve M. Archer sent a representative to Europe to study the major solvent extraction plants, and the next year started operation of a one-hundred-fifty-ton per day Hildebrandt continuous solvent extraction unit, thus becoming first in this country to produce soy products by that process.

Walter Flumerfelt, now a successful processor in Waterloo, Iowa, had operated a small solvent plant at Monticello, Illinois, for two years beginning in 1929. It was the first actual business venture of this type, and Flumerfelt's patent on continuous solvent extraction is now used on wheat germ extraction. Much helpful information came out of the Monticello venture.

While Archer-Daniels-Midland Company began processing by expeller in 1929, their big push in the industry came with entrance into the solvent extraction field, where they were first in volume production and merchandising

of this type of 44 per cent protein meal. In research work and merchandising of solvent extracted soybean oil meal, long popular in Europe, they spent a fortune of substantial proportions. In this project alone there is a most interesting merchandising story that has yet to be written as a future guide to other industries.

At the outset the new solvent product was placed on consignment with all types of dealers and distributors over a wide area.

Says Vice-President Whitney H. Eastman: "We might just as well have placed it on the shelves of jewelry stores in Iceland."

Years of terrific sales plugging and skillful merchandising policies brought about the present easy acceptance and a growing demand that absorbs a larger volume each year. A number of other major companies now produce the solvent extracted meal, including The Glidden Company which entered the soybean business in 1934, Central Soya Company, Inc., which first processed soybeans in December 1934, and now is an important factor in the industry under the driving force of D. W. McMillen, long active in the feed trade, The Buckeye Cotton Oil Company, which entered the industry in 1935, and The Drackett Company, comparatively a newcomer. The Clinton Company uses the method on a smaller volume. Several of these manufacturers also produce expeller meal. Before launching his solvent extraction plant, McMillen sent men from his laboratory and technical staffs to Europe for a thorough study of methods available, and on the basis of their reports he installed equipment for the Hansa-Muehle production operation. For the grand opening of this new solvent extraction plant in the autumn

of 1937, special cars were run to Fort Wayne, Indiana, with delegations representing all branches of the industry, leaders in grain marketing, bankers and financiers, and university and government scientists, for an inspection trip and a later banquet and speaking program that filled the local auditorium.

Capacity of solvent process now represents about 20 per cent of the industry's total capacity.

Long before the Goodrich Company was acquired by Archer-Daniels-Midland Company it had studied the refinement of Manchurian soybean oil and in the early 1920's clarified soy oil was developed, along with a number of other special oils. This was a forward step of some consequence.

Only tariff protection saved the soybean industry from being nipped in the bud and permitted manufacturers to expand the grower's market. Even before the industry developed there was a group of vegetable oil processors and agriculturists seeking domestic protection from the Manchurian inroads, and progress was made under the tariff act of 1913. For the next eight years "free traders" sought to destroy this protection. In these battles Whitney Eastman took an active part. In 1921 this small group fought through a duty of twenty cents a gallon on cottonseed and soybean oils, increases of taxes on some other competing oils, and a duty lift to thirty cents a bushel on flaxseed. There were further battles and further gains in 1922, 1930 and 1936, until the soybean farmer felt that at least his expansion program could not be destroyed overnight by defective tariff rates.

During five years of this legislative drive beginning in 1930, Whitney Eastman had served

processors' association, his company meanwhile moving forward in its expansion program, until today it has soybean processing plants in six cities, and far-flung merchandising facilities here and abroad.

Allied Mills, Inc., had begun processing under a former corporate name in 1927 and John B. DeHaven, now president, has been active in all development projects, as has also John H. Caldwell of Ralston Purina Company, which entered the field in 1930, and is one of the largest, if not the largest, single consumers of soybean oil meal. Spencer Kellogg and Sons, Inc., stepped into the industry in 1935 and now has plants in four cities, under the personal direction of Howard Kellogg, Jr., and Swift & Company crushes beans at four plants, having begun operations in 1937.

Processors have never lacked courage. On October 23, 1929, the first day of the great stock market crash, Shellabarger Grain Products Company began soybean processing, built up a successful business that was purchased three years ago by Spencer Kellogg and Sons, Inc.

In that same shaky period the mills of two present successful processors—Standard Soybean Mills and Iowa Milling Company—began grinding the soybean and betting on its future in a field crowded with competitive articles.

## CHAPTER 5

### BREEDING NEW TYPES

Back of every onward impulse for crop expansion in the soy belt, or in scattered districts beyond the belt, may be found the tireless research of the plant scientists. Results of their designs and schemes and ingenuity with nature are etched in the landscape.

The story of breeding types and varieties of soybeans for varying soils and climatic conditions is in truth a colorful chapter in the history of modern agriculture. It can only be touched upon here. The bibliography provides a guide to details.

In this breeding effort—a basic and invaluable work—Hackleman is credited with contributing to the fruitful results.

He came out of Missouri, where he had labored with soybeans for a few years, and joined the staff of the University of Illinois. He made quite clear at the time his desire to continue cooperative work with Washington. The request was readily granted and such work went forward. Interest among growers and others was not really whipped up to high pitch until after Hackleman had gotten well under way his extensive series of county tests.

He started these tests in about 1915. In a single year he had twenty-four in progress in different counties. They were continued well into the 1920's. He not only put the tests out in numerous counties, but followed them through

with utmost care. Sometimes he and Bill Morse would go barnstorming through the state for three weeks at a stretch. They held meetings where the tests were being demonstrated, sometimes three or four in a day. Many credit Hackleman more than any other single individual with the subsequent immense expansion in Illinois. This early work was most ably buttressed by Burlison, who later added great force to the movement, while Wiggans in New York and Williams in North Carolina, and various others were busily creating types suitable for local production.

In China almost every village has its own distinct variety. There is no seed trade, so local varieties are never widespread.

In this country it would be highly desirable to limit the number of varieties in the trade. But, unfortunately, to obtain best results each region must have local types adapted to different purposes.

Hardy in drouth and resistant to disease, the bean is sensitive to soil and climate changes. Striking variation in behavior of the same pure line variety is shown in different districts. Hackleman and others realized these facts and aimed their work accordingly. In the early effort it became plain that introductions from localities in the Orient differed widely in their adaptation to scattered American regions. The conclusion was that by careful selection, strains adapted to locality and purpose could be developed. The workers hewed to this line. Commercial plantings increased. It was found by such experiments that new types are better adapted than commonly grown varieties, hence the continued effort to develop types for specific location and specific purpose.

A hundred named varieties now are generally grown, or are being increased for greater distribution in this country.

Since 1929 the use of soybeans by processors has led to a demand for yellow-seeded varieties of high oil content. Agronomists have sought to meet this demand. Their experiments have brought about creation of several superior oil varieties, thus increasing production for milling purposes. Most popular among these varieties are Illini, Dunfield, Mukden, Mandell, Scioto, Mansoy, Manchu, Mandarin, Arksoy and Macoupon. It seems possible, in light of present studies, to produce varieties high or low in oil within the known oil content ranges.

A bulletin comprehensively covering eleven years (1927-37) of soybean investigation in Illinois was issued by Burlison, C. A. Van Doren, and Hackleman. The trials were a continuation of those begun at the Illinois Station in 1906.

Yields and performance of sixty-five varieties and strains were tested and observed. The beans were planted in north, central and southern Illinois. Yields of hay and straw and beans were measured. Tests were made of the effects of different dates, rates and methods of seeding on the yield of soybeans. These experts likewise studied the effects of storage on germinability and chemical properties of the seed.

After the tests came recommendations for particular varieties in the various sections of Illinois, the giant producer among states. Recommendations were based not only on quantity yields, but also on shattering, lodging, color of bean and time involved for maturing:

Northern Illinois	Central Illinois	Southern Illinois
Manchu Selection (Thomas)	Illini	Morse Selection 230
Manchu (Thomas)	Dunfield	Scioto
Manchu (Wisconsin)	Manchuria 13-177	Mansoy
Strain B	Manchu	Macoupin
Black Eyebrow		Manchuria 13-177
		Illini

It was found that straight hay varieties did not yield either more or better hay than the grain varieties. Hence there seemed no reason to change the practice of growing grain-type beans for hay.

Soybean plants of sixteen varieties in the best stage of growth for hay production, that is, pods well filled but leaves not yet starting to fall, averaged about one-third leaves, one-third stems, and one-third pods when the different parts were oven-dried and weighed.

In the process of field-curing and harvesting twenty-four varieties of soybeans for hay, approximately 74 per cent of the oven-dry weight of leaves, 77 per cent of the stems, and 89 per cent of the pods were saved.

In seeding practices, beans seeded in rows twenty-four inches apart gave higher acre-yields than those seeded in rows eight inches apart. Increasing or decreasing the rate of seeding showed no consistent effect on grain yields over a period of five years. For beans drilled in rows eight inches apart, seedings of from ninety to one hundred and thirty pounds an acre averaged slightly better yields than the other returns. For beans drilled in rows twenty-four inches apart, seedings of from fifty to seventy pounds an acre averaged slightly better yields than the other returns.

May seedings produced higher bean yields than June seedings. But there were no marked differences in yields

from the various May seedings—May 1, May 10, and May 20.

Better types and varieties and better machinery have gone hand in hand. In the early days, points out John T. Smith, Master Farmer of Illinois, it was almost impossible to get a threshing machine to thresh the crop. Harvesters refused to handle the beans, "being more skeptical than the cow."

As time went on harvesting was done with a binder, thresher men finally accepting soybeans as a necessary evil. They grudgingly threshed them for twenty cents a bushel, later coming down to ten cents.

The old Gordon machine was said to be the first horse-drawn soybean harvester in the United States. It was a crude contraption with a huge drumlike affair resting on two wagon wheels. In its advertising it featured: "The man in the rear rides." Then there was the Little Giant Bean Harvester that now looks as outdated as the first gasoline buggy. Its advertising boasted it could hold fifteen bushels before stopping to empty, but insisted on beans being planted in rows.

In the course of years, improved machinery contributed to broadening production. The combine of the wheat fields was brought into play. The old method of cutting with the binder, shocking and threshing with the threshing machine was a costly operation. The first combines introduced were the twelve-foot machines used for wheat. As there were few machines and a big demand for custom-harvesting people began buying ten- to twenty-foot cutter-bar machines. Now there is a definite trend back to smaller combines with five- to six-foot cutter-bars for the average farm. These little machines will cut two rows at a

time. They can be operated by one man and under favorable conditions can cut and thresh fifteen acres a day.

From the production standpoint the trend is definitely to row beans. As to the width of rows, growers are still experimenting. At the present time the corn-planter width row seems to be growing in favor, although many prefer from twenty-one- to twenty-eight-inch row width.

R. H. Wilcox of the University of Illinois made public extensive studies on machinery improvement. For three years ending 1924, thirteen man-hours, twenty-nine horse-hours and three-quarters of a tractor-hour were required to grow and harvest an acre of soybeans. During the three years ending 1939 the number of man-hours had declined to four. The number of horse-hours had dropped to less than one. The number of tractor-hours had increased to 2.4 an acre.

This study shows costs very high for producing soys in the early 1920's. After 1930, however, their competitive position in the crop rotation improved. From a place among the non-profit farm crops (with the exception of 1929), soybeans began gradually to climb into the group of profitable farm crops. Now, says Wilcox, the crop ranks next to corn in profit per acre.

In this study it is shown too that the competitive position of soybeans in the five years ending in 1939 provided the reason for rapid expansion in that period. Soybeans had an average farm price approximating seventy-six cents a bushel and an average yield of twenty-eight bushels on a group of selected farms. Hence they proved more profitable than did wheat yielding twenty-three bushels an acre and worth seventy-eight cents a bushel on the farm at harvest time.

Without the scientific studies of plant breeders and culture experts the expansion could not have been attained. They cleared the way. Growers, processors and machinery makers followed through.

# SOYBEANS

## SOYBEANS—ORIGIN AND

VARIETY	ORIGIN	YEAR	DAYS TO MATURE
Agate	Introduction, Japan	1929	90
A. K.	" Manchuria	1912	110
Aksarben	" "	1913	105
Aoda	" Japan	1929	140
Arisoy	" "	1930	170
Arksoy	Introduction, Chosen	1914	140
Avoyelles	Selection, La.	1932	170
Bansei	Introduction, Japan	1929	110
Barchet	" China	1908	150
Biloxi	" "	1908	165
Black Eyebrow	Introduction, Manchuria	1911	105
Cayuga	" "	1925	100
Chame	" Japan	1929	125
Charlee	" China	1927	165
Chief	Cross—Woodworth, Ill.	1932	110
Chernie	Introduction, Siberia	1906	100
Chestnut	Selection, U.S.D.A.	1907	105
Chiquita	Introduction, China	1910	135
Chusei	" Japan	1929	110
Clemson	" China	1927	160
Columbia	Introduction, China	1908	125
Creole	" "	1927	165
Delnoshat	Selection, York, Miss.	1924	165
Delsta	" " "	1924	150
Dixie	" U.S.D.A.	1914	135

\* bl = black; br = brown; de = dry edible beans; f = forage;  
or greenish yellow; p = purple; pa = pale; sy = straw yellow;

## VARIETAL CHARACTERISTICS\*

FLOWER COLOR	PUBES- CENCE COLOR	SEED CHARACTERS						PRO- TEIN %	USE
		Coat Color	Germ Color	Hilum Color	Seed per Pod	Seed per Pound	Oil %		
p w	t	sy & br	y	br	2-3	2.816	19.2	37.3	gv
p w	g t	sy	y	pa to bl	2-3	2.650	18.8	44.7	gra f
p w	g	sy	y	y	2-3	2.675	19.6	38.3	gra
p	g	gr	gr	br	2	1.424	18.5	41.0	gv de
p	t	sy	y	br	2	3.600	16.3	43.0	gra
p	g	sy	y	br	2-3	3.136	17.0	48.1	gra
p	t	bl	y	bl	2-3	3.248	18.4	42.1	f
p	g	sy	y	y	2-3	1.936	21.7	39.1	de gv
p	t	br	y	br	2-3	9.950	13.9	48.0	f
p	t	br	y	br	2-3	1.875	19.2	46.8	f
p w	t	bl & br	y	bl	2-3	2.475	21.9	39.6	f
w	t	bl	y	bl	2-3	3.632	18.9	39.8	f gra
w	t	br	y	br	2-3	1.904	21.8	37.1	gv
p	t	sy	y	bl	2-3	3.824	18.5	42.9	gra f
p	g	sy	y	bl	2-3	3.552	21.4	39.2	gra
p	t	bl	y	bl	2-3	4.675	18.3	44.2	f
p	t	br	y	br	2-3	3.275	18.2	43.0	f
p w	g	sy	y	br	2-3	4.050	18.2	43.8	f gra
w	g	sy	y	y	2-3	2.096	15.0	44.3	de gv
p	t	sy	y	bl	2-3	3.680	17.4	44.9	gra f
p w	g	gr	gr	br	2-3	3.350	18.7	38.0	f
p	t	sy	y	bl	2-3	3.120	16.9	45.5	f gra
w p	g	sy	y	br	2-3	2.340	20.5	47.6	gra
w	g	sy	y	br	2-3	1.860	18.4	41.0	gra
p	g	sy	y	y	2-3	1.825	19.4	45.0	gra

g = gray; gr = green; gra = grain; gv = green vegetable; oy = olive  
t = tawny; w = white.

## SOYBEANS—ORIGIN AND

VARIETY	ORIGIN	YEAR	DAYS TO MATURE
Dunfield	Introduction, Manchuria	1913	110
Easycook	" China	1894	135
Ebony	" Chosen	1901	125
Elton	" Siberia	1906	105
Emperor	" Japan	1929	120
Etum	Introduction, Japan	1930	105
Fuji	" "	1929	115
Funk Delicious	" Funk Bros., Ill.	1932	125
George Washington	Selection, Clapp, Va.	1921	135
Georgian	Introduction, China	1927	165
Giant Green	Introduction, Japan	( <sup>b</sup> )	100
Goku	" "	1929	110
Habaro	" Siberia	1906	105
Haberlandt	" Chosen	1901	130
Hahto	" Japan	1915	130
Hakote	Introduction, Japan	1929	115
Harbinsoy	Selection, U.S.D.A.	1922	120
Hayseed	Introduction, China	1927	160
Herman	Selection, Herman, N. C.	1915	135
Higan	Introduction, Japan	1929	135
Hiro	Introduction, Japan	1930	115
Hokkaido	" "	1930	115
Hollybrook	Selection, Wood, Va.	1902	135
Hongkong	Introduction, China	1908	120
Hoosier	" Manchuria	1911	110
Hurrelbrink	Selection, Hurrelbrink, Ill.	1902	125
Illini	" Woodworth, Ill.	1921	105
Ilsoy	" Smith, Ill.	1913	120
Imperial	Introduction, Japan	1929	125
Ito San	" "	1890	105

<sup>b</sup> Unknown.

## VARIETAL CHARACTERISTICS \*—Continued

FLOWER COLOR	PUBES- CENCE COLOR	SEED CHARACTERS						PRO- TEIN %	USE
		Coat Color	Germ Color	Hilum Color	Seed per Pod	Seed per Pound	Oil %		
p w	g	sy	y	br	2-3-4	3.175	20.8	39.7	gra
p	g	sy	y	br	2-3	2.700	21.5	38.3	de gra
p w	t	bl	y	bl	2-3	5.750	16.9	41.4	f
p	g	sy	y	y	2-3	2.625	18.3	42.5	gra
p	g	sy	y	pa	2	1.250	19.3	42.4	gv de
p	g	sy	y	br	2-3	1.568	17.3	40.2	gv de
p w	t	oy	y	bl	2-3	1.456	18.5	42.3	gv
p	g	sy	y	pa	2	1.600	17.4	41.3	gv de
p	t	br	y	br	2-3	3.200	20.7	45.9	f
p	t	sy	y	pa-br	2-3	3.968	17.4	45.6	f gra
p	t	gr	gr	bl	2	1.536	21.0	42.9	gv
w	g	sy	y	br	2-3	3.216	14.6	45.5	gv
p w	g t	sy	y	br	2-3	3.100	20.6	39.9	gra
p w	t	sy	y	br	2-3	2.400	19.2	41.7	gra de
p	t	oy	y	bl	2-3	1.250	15.6	42.8	gv de
w	t	oy	y	bl	2-3	1.440	18.4	43.8	gv de
w	t	sy	y	br	2-3	2.950	19.9	44.2	f gra
w	t	sy	y	br	2-3	4.176	19.5	45.7	f gra
p	t	sy	y	br	2-3	2.450	21.8	42.2	gra
p	g	sy	y	br	2-3	1.984	22.4	32.4	gv de
w	t	bl	y	bl	2-3	1.312	16.1	46.8	gv
p w	g	sy	y	y	2-3	1.232	21.1	37.4	gv de
w	g	sy	y	br	2-3	2.550	16.4	44.1	gra
p w	g t	sy	y	br	2-3	3.125	19.0	43.5	gra
p w	g	sy	y	br	2-3	2.510	19.3	41.8	gra
p	t	sy	y	br	2-3	2.800	19.0	43.5	gra
w	g	sy	y	br	2-3	2.750	20.4	39.3	gra
p	t	br	y	br	2-3	3.250	18.1	38.2	f
p	g	sy	y	pa	2	1.920	19.9	41.2	gv de
p	t	sy	y	y	2-3	3.325	18.1	41.5	gra

# SOYBEANS

## SOYBEANS—ORIGIN AND

VARIETY	ORIGIN	YEAR	DAYS TO MATURE
Jogun	Introduction, Japan	1930	118
Kanro	“ Chosen 84668	1929	110
Kanum	“ Japan	1930	110
Kingwa	Selection, Garber, W. Va.	1921	125
Kura	Introduction, Japan	1929	118
Laredo	Introduction, China	1914	140
Lexington	Selection, U.S.D.A.	1907	130
Macoupin	“ Hulcher, Ill.	1930	125
Magnolia	Introduction, Chosen 85537	1929	137
Mamloxi	Selection, York, Miss.	1925	145
Mammoth Brown	Selection, Unknown	(b)	140
Mammoth Yellow	Introduction, origin unknown	1880	145
Mamredo	Selection, York, Miss.	1924	150
Manchu	Introduction, Manchuria	1911	110
Mandarin	“ “	1911	100
Mandell	Selection, Cutler, Ind.	1926	115
Mansoy	“ U.S.D.A.	1915	120
Medium green	Introduction, Japan	1889	120
Midwest	“ China	1901	115
Mingo	Selection, Park, Ohio	1938	115
Minsoy	Introduction, France	1910	100
Misoy	“ China	1927	160
Monetta	“ China	1927	165
Morse	“ Manchuria	1906	130
Mount Carmel	Selection, U.S.D.A. Ind.	1940	130
Mukden	Selection, U.S.D.A.	1921	105
Nanda	Introduction, Chosen	1932	145
Nanking	“ China	1927	165
Norredo	Selection, unknown	(b)	125
Ogemaw	“ Evans, Mich.	1902	90

## VARIETAL CHARACTERISTICS \*—Continued

FLOWER COLOR	PUBES- CENCE COLOR	SEED CHARACTERS						PRO- TEIN %	Use
		Coat Color	Germ Color	Hilum Color	Seed per Pod	Seed per Pound	Oil %		
w	g	sy	y	y	2-3	1.360	17.1	44.0	gv de
p	g	sy	y	pa br	2-3	1.488	17.8	43.9	gv de
p	g	sy	y	br	2-3	1.776	17.9	38.4	gv de
p	g	bl	y	bl	3	3.808	15.5	42.3	f
w	t	bl & oy	y	bl	2	1.456	20.4	40.9	gv
p w	t	bl	y	bl	2-3	7.775	14.9	42.9	f
p w	g	oy	y	br	2-3	3.585	18.7	41.4	f
w	g	sy	y	br	2-3	2.944	21.5	39.4	gra
p	g	sy	y	pa	2-3	3.488	18.2	39.8	gra
w	g	sy	y	br	2-3	2.852	18.6	46.1	gra
p	t	br	y	br	2-3	1.855	17.8	44.1	f gra
w	g	sy	y	br	2-3	2.150	19.6	45.8	gra
w	g	sy	y	br-bl	2-3	3.220	18.4	43.0	gra
p w	t	sy	y	bl	2-3-4	2.350	18.9	41.4	gra
p	g	sy	y	y	2-3	2.910	18.5	44.0	gra
p	t	sy	y	bl	2-3	2.448	19.0	44.5	gra
p	t	sy	y	bl	2-3	2.450	21.0	39.2	gra
p	t	gr	gr	br	2-3	2.485	20.5	38.8	f
p	t	sy	y	y-br	2-3	3.675	17.6	44.1	gra
p	t	sy	y	bl	2-3	3.600	19.5	41.4	gra
p	t	sy	y	br	2-3	3.700	18.5	43.2	gra
p	t	sy	y	bl	2-3	4.320	19.2	42.2	gra f
p	t	sy	y	bl	2-3	2.976	17.5	42.3	f gra
p w	g	oy	y	br	2-3	2.500	20.7	40.0	f gra
p	g	sy	y	bl	2-3	2.960	21.5	43.2	gra
w	g	sy	y	br	2-3	2.750	18.9	45.9	gra
p	g	sy	y	pa	2	1.952	17.4	46.2	gv
p	t	sy	y	br	2-3	5.600	14.1	47.5	gra
p w	g t	bl	y	bl	2-3	5.856	16.0	41.4	f
w	t	br	y	br	2-3	3.125	21.5	35.9	f

## SOYBEANS—ORIGIN AND

VARIETY	ORIGIN	YEAR	DAYS TO MATURE
Old Dominion	Introduction, China	1917	140
Oloxi	Cross—Wilds, S. C.	(b)	170
Ontario	Introduction, Manchuria 65344	1925	105
Osaya	" Japan	1929	115
Otootan	" McClelland, Ark.	1911	175
Ozark	Introduction, Chosen	1914	130
Palmetto	" China	1927	165
Patoka	Selection, Cutler, Ind.	1940	130
Pee Dee	Cross—Wilds, S. C.	(b)	145
Peking	Selection, U.S.D.A.	1907	125
Pine Dell Perfection	Selection, Griesenauer, Va.	(b)	130
Pinpu	Introduction, Manchuria	1910	105
Richland	Selection, U.S.D.A.	1927	105
Rokusun	Introduction, Japan	1929	140
Sato	" "	1929	115
Scioto	Selection, Park, Ohio	1925	120
Seminole	Introduction, China	1931	165
Seneca	Selection, U.S.D.A.	1921	105
Shiro	Introduction, Japan	1929	115
Sioux	" "	1929	85
Sooty	Selection, U.S.D.A.	1907	125
Sousei	Introduction, Japan	1929	115
Southern Green	" China	1925	145
Southern Prolific	" Chosen	1914	135
Soysoa	" Italy	1910	100
Suru	Introduction, Japan	1930	115
Tarheel Black	" China	1905	140
Tastee	" Japan	1930	115
Toku	" Japan	1930	115
Tokyo	" Japan	1901	140

## VARIETAL CHARACTERISTICS \*—Continued

FLOWER COLOR	PUBES- CENCE COLOR	SEED CHARACTERS						PRO- TEIN %	USE
		Coat Color	Germ Color	Hilum Color	Seed per Pod	Seed per Pound	Oil %		
p	g	br	y	br	2-3	6.525	14.8	46.1	f
p	t	bl	y	bl	2-3	4.100	14.8	44.9	f
p	t	sy	y	bl	2-3	3.056	19.8	42.8	gra
w	g	sy	y	y	2-3	1.792	18.1	46.3	gv de
p	t	bl	y	bl	2-3	6.150	16.4	45.6	f
p	t	br	y	br	2-3	2.800	18.6	46.1	gra f
p	t	sy	y	bl	2-3	3.408	16.9	44.3	gra f
p	g	sy	y	bl	2-3	2.672	21.6	42.6	gra
p	t	bl	y	bl	2-3	5.100	14.0	43.3	f
p w	t	bl	y	bl	2-3	6.388	15.2	38.7	f
p	t	bl & br	y	bl	2-3	3.696	18.3	40.3	f
p	g	sy	y	br	2-3	2.675	20.4	40.0	gra
p	g	sy	y	br	3	3.232	19.6	35.4	gra
p	t	sy	y	br	2-3	1.584	18.1	43.2	gv de
w	t	bl	y	bl	2-3	1.488	17.5	48.7	gv
p	t	sy	y	bl	2-3	2.960	22.2	38.2	gra
p	t	sy	y	br	2-3	1.600	19.6	46.1	gra gv
w	g	sy	y	br	2-3	5.184	19.0	39.0	gra
w	t	oy	y	br bl	2-3	1.632	18.7	42.3	gv
p	t	oy	y	bl	2	3.000	15.7	50.2	gv
p w	t g	bl (dull)	y	bl	2-3-4	5.825	16.3	41.6	f
p	t	oy	y	br	2-3	1.840	16.0	48.4	gv de
w	g	gr	gr	br	2-3	2.576	23.2	40.9	f
p	g	sy	y	br	2-3	2.350	19.5	46.4	gra
p	t	br	y	br	2-3	4.900	19.9	44.6	f
p w	g	sy	y	y	2-3	1.320	21.6	39.2	gv de
p w	t	bl	y	bl	2-3	2.710	17.8	45.5	f
p	t	oy	y	bl	2-3	1.472	17.0	41.7	gv
w	g	sy	y	br	2-3	1.952	17.6	43.0	gv de
p	g	oy	y	pa	2-3	2.260	19.3	45.5	gra de

## SOYBEANS—ORIGIN AND

VARIETY	ORIGIN	YEAR	DAYS TO MATURE
Virginia	Selection, U.S.D.A.	1907	125
Waseda	" U.S.D.A.	1929	110
Wea	" Manchuria	1911	110
White Biloxi	" York, Miss.	1925	165
Willomi	" U.S.D.A.	1931	115
Wilson	Introduction, Manchuria	1906	125
Wilson Five	Selection, U.S.D.A.	1912	125
Wisconsin Black	" Wis. Experiment Sta.	1898	100
Wood's Yellow	" Woods, Va.	1934	135
Yelredo	Cross—Wilds, S. C.	( <sup>b</sup> )	165
Yokoten	Introduction, Japan	1907	130

Specially prepared by Division of Forage Crops and Diseases, Bureau

## VARIETAL CHARACTERISTICS \*—Continued

FLOWER COLOR	PUBES- CENCE COLOR	SEED CHARACTERS						PRO- TEIN %	USE
		Coat Color	Germ Color	Hilum Color	Seed per Pod	Seed per Pound	Oil %		
p	t	br	y	br	2-3	3.455	19.8	40.1	f
p w	t	sy	y	pa br	2-3	2.016	18.5	43.4	gv de
p	g	sy	y	br	2-3	3.246	21.9	38.8	gra
p	t	sy	y	br	2-3	2.230	17.1	46.6	gra
p	g	sy	y	br	2-3	1.500	18.3	44.6	gv de
p w	t g	bl	y	bl	2-3	2.400	17.3	44.0	f
p	g	bl	y	bl	2-3	5.025	16.0	44.1	f
p	t	bl	y	bl	2-3	3.085	16.4	46.1	f
w	g	sy	y	br	2-3	1.600	17.7	44.7	gra
p	t	sy	y	br	2-3	5.120	18.2	45.2	gra f
p w	g	sy	y	br	2-3	2.175	19.5	39.1	gra

of Plant Industry, U.S.D.A.

## CHAPTER 6

### SCIENTISTS COMMEND PRODUCT

The steep climb to high popularity of soybean oil meal as a feed for all classes of livestock and poultry came on the heels of many feeding tests by agricultural colleges, buttressed by nation-wide merchandising campaigns.

In the family of vegetable proteins soybean oil meal is declared by authorities to have no superior in livestock feeding practices. It contains proteins highest in digestibility to animals. These proteins are characterized as more complete than proteins of other supplements of vegetable origin, and of many proteins of animal origin, in the content of amino acids essential to growth, milk, wool and egg production and to body repair.

There are three types of manufacture. One is the hydraulic method, which is now used only in small degree, the expeller method by which the largest volume is produced, and the solvent extraction method, volume from which has grown substantially in recent years.<sup>1</sup>

The meal is the product derived from soybeans by processing to remove a large part of the excess oil. Experimental work has shown that soybeans and soybean oil meal must be properly heat-treated to give proteins a satisfactory biological or feeding value. Such treatment is con-

<sup>1</sup> Technical details of processing soybeans and the various mechanical methods used may be obtained by writing the U. S. Regional Soybean Industrial Products Laboratory, Urbana, Ill.

veniently applied in manufacture. Thus an excellent product may be produced by any of the three methods of manufacture.

Incidentally, it has been found that raw, uncooked soybeans contain protein inferior in availability for critical animals. They likewise contain a superfluous amount of oil for best results with meat animals. Ground, raw soybeans are sometimes loosely alluded to as soybean meal. This causes some confusion. Results of feeding tests have clearly indicated the undesirability of feeding the raw, uncooked soybean. For example, one test proved that when hogs were fed raw soybeans with minerals, as a supplement to corn, they made the unsatisfactory gain of 0.5 to 0.7 pounds daily and required from four hundred and fifty to five hundred and fifty pounds of feed per one hundred pounds of gain. At the same time soybean oil meal was fed identically. Hogs thus fed gained from one and four-tenths to one and seven-tenths pounds daily. In this latter test from three hundred and seventy to three hundred and ninety-five pounds of feed were required to produce one hundred pounds of gain. Besides the unsatisfactory gains on raw soybeans, hogs thus fed also produce unsatisfactory soft pork. In the past, packers have avoided purchases in some districts where whole raw soybeans were being fed.

In hog feeding there has been a steady broadening out of the product. Hog feeders and breeders were among the first to recognize its value. Perhaps this is due in part to the fact that the beans have been grown and the meal processed in near proximity to the hog growing sections. Until the advent of soybean oil meal, hog feeders depended almost entirely on animal sources of protein even

though several vegetable proteins were available. Acceptance has been enhanced by reason of the variety and balance of protein contained in soybean oil meal.

Many hog feeding comparisons have been conducted by state agricultural experiment stations with soybean oil meal and various other protein sources, such as tankage, meat scraps, and fish meal. In these tests, soybean oil meal, properly supplemented with minerals, has given results in practically all instances equal to any one of the above mentioned animal proteins. However, it likewise has been demonstrated in additional experiments that significantly better results in the rate and economy of gains for hogs are attained by combining soybean oil meal with such proteins as tankage, and fish meal, along with proper minerals and alfalfa meal for dry lot, in contrast to using any one of these protein feeds alone as a supplement to grains for hogs.

The above is evidence of the tremendous popularity of soybean oil meal in rations for hogs of all ages and explains why hog men constitute one of its largest users, either as soybean oil meal or in commercial hog feed mixtures.

In the case of dairy cattle, it has been shown that protein can be purchased cheaper in soybean oil meal than it can be supplied by feeding soybeans at market prices even though raised on the farm of the feeder.

Dairy cattle are at present the largest consumers of this product. It is considered one of the most palatable feeds for these animals and its proteins are more digestible than other proteins of vegetable origin. Impartial authorities have conducted tests that prove there is no fear of causing scours in cattle or of producing soft undesirable butter

fat as in the case of feeding whole ground soybeans at high levels.

Times and conditions change, old ideas and methods are discarded. A few years ago the average feeder seldom considered soybean oil meal as part of the ration for fattening beef cattle or sheep. But he had begun to realize that a protein supplement in addition to corn and hay was essential. He thought first of two other popular vegetable proteins. But findings on the newcomer, soybean oil meal, began to blossom out in bulletins from agricultural colleges. Again there was established its equality in some cases and its superiority in most to competitive feeds when used as a supplement for beef cattle and sheep.

Extensive experimental data can be obtained on this general subject from Iowa State College, Ohio State University, University of Illinois, Purdue University, Cornell University, and others. Said one research worker: "Soybean oil meal has now become the yardstick by which vegetable proteins are measured."

The little red hen has been extolled down the ages for her contributions to the advancement of mankind and a glance at the Department of Agriculture reports on the value of the poultry crop indicates its economic importance. In recent years new profits have been drawn from that industry through more scientific feeding. Research by state and federal agencies and feed manufacturers has developed rations whose nutritional adequacy has definitely added to money returns. In this industry there has been a steady and rapid increase in usage of soybean oil meal. Experts who refer to it as a "complete protein," have found it to have a full complement of the essential amino acids so necessary for optimum growth, produc-

tion and reproduction. It contains an appreciable amount of several vitamins required by poultry. Poultry experts advise its use in combination with other vitamin-carrying ingredients. This protein usually costs less than proteins from animal sources. Thus its high nutritive value makes it advantageous for the poultry man to use feeds in which a portion but not all of the animal protein of the ration has been replaced with soybean oil meal and minerals. Poultrymen say, moreover, that it has the advantage of not influencing egg yolk color as do some plant concentrates. It is a standard product of little variation.

More than three-fourths of a million dogs are registered in the American Kennel Club and similar dog clubs. This is in addition to the fifteen million of cross-bred and non-registered dogs in the United States. There are two hundred brands of dog feeds, and more than five hundred million pounds are sold annually in this country. Dog feed manufacturers realize the importance of the excellent source of protein in properly processed soybean products. They have used millions of pounds in canned or dry dog feeds. Says one expert: "It is a well-advised and usual practice to furnish the protein in a dog feed, primarily from meats, soybean products, milk and grain. In addition to providing excellent protein, processed soybean products contain appreciably more of the minerals, calcium and iron than grain and grain products." Such properly processed products likewise go into the feeding of foxes and other fur-bearing animals. The Federal Fur Animal Experiment Station at Saratoga Springs, New York, has conducted feeding experiments with foxes with a processed soybean product as a portion of the protein-bearing material in dry type rations. Excellent results were obtained and very ap-

preciable savings in the cost of the feed were noted.

In the crop year ending September 30, 1929, production of soybean oil meal totaled forty thousand tons. In the crop year ending September 30, 1940, production totaled one million three hundred and forty thousand and two hundred tons. Some 95 per cent of all the soybean oil meal produced has been used in the feeding of livestock and poultry.

UNITED STATES CROP; PRODUCTION OF SOYBEAN  
OIL MEAL AND SOYBEAN OIL, 1924-40

CROP YEAR*	PRODUCTION (000 bu.)	CRUSHINGS (000 bu.)	PRODUCTION	
			Meal (000 tons)	Oil (000 lbs.)
1924	4,947	307	7.4	2,269
1925	4,875	351	8.4	2,638
1926	5,239	335	8.0	2,659
1927	6,938	559	13.4	4,374
1928	7,880	883	21.2	7,285
1929	9,398	1,666	40.0	13,424
1930	13,471	4,069	97.7	34,688
1931	16,733	4,725	113.4	39,945
1932	14,975	3,470	84.7	29,078
1933	13,147	3,054	73.9	26,197
1934	23,095	9,105	223.0	78,125
1935	44,378	25,181	599.9	208,964
1936	29,983	20,618	493.2	183,711
1937	45,272	30,310	716.2	279,279
1938	62,729	44,648	1,076.4	416,112
1939	91,272	56,684	1,340.2	533,417
1940	77,374	64,180	1,536.9	565,169
1941	106,712			

\* Oct. 1-Sept. 30.

SOURCE: Government reports.

## CHAPTER 7

### LAKES OF OIL

A lively commercial war has been fought in the field of edible fats and oils. One of the victors seems to be the soybean.

Producers of domestic fats and oils have seen broad revision in the agriculture of their respective regions in the past decade. Reduced cotton acreage has been turned to peanuts or other cash or feed crops. Surplus corn acreage has been planted to new items, including soybeans. Soys yield more oil than like acreage in corn, in the form of lard, when fed to hogs. These and other shifts and world events have ushered in phenomenal changes. The impact has been severe. More startling struggles may lie ahead.

Against all odds soybean oil has become deeply entrenched. Four factors in this success come to mind: merit, superior chemistry, price, and smart merchandising.

Bear in mind that edible or industrial fats and oils or both may be obtained not only from such major products as hogs, cows, cottonseed, linseed, soybeans and the like, but from a long list of seeds and nut kernels, from whales, and even from certain cockleburs and thistles. The lakes of edible and industrial oils care for the consumptive demand totaling more than seventy-five pounds per person annually.

Staring into test tubes with the repressed excitement of prospectors panning sandy streams for gold, chemists are

forever making new contributions to the forward stride and evolution of soybean oil. It still lacks perfection in the eyes of the critical men of the laboratories.

But well over 80 per cent of the 1939 production of five hundred and thirty-three million, four hundred and seventeen thousand pounds was used for edible purposes, and was consumed as shortening, 54.5 per cent; margarine, 19.2 per cent; and salad oil, 8.8 per cent. The remainder went into industrial uses. The 1940 total was larger.

Experience with Manchurian oil in the early days added to normal resistance to the new product. So it beat its way in as a substitute for linseed and other drying oils in the making of paint, varnish and linoleum. That was the line of least resistance. But the field soon became too narrow.

A method was evolved for refining the oil for edible use. In 1930 the Staley Company sold the first tank car to a margarine manufacturer. In fact, the total output of the refined article went into margarine that year, some two and a quarter million pounds.

Then a curious thing happened. The oil gave margarine a rich yellow, butterlike color. So restrictive laws were promptly enacted. In the next five years, however, research proved that the oil could be hydrogenated and used in margarine with admirable results. By 1935 nearly four million pounds were so used and by 1939 some seventy million pounds. The total since has steadily grown.

Soybean oil for some years has been the lowest priced edible domestic oil.

Unlike cottonseed oil, soybean oil is obtained from a crop grown on mechanized farms and requires a minimum of human labor. This factor leads to a relatively low stable price. Moreover, it points to possible use as a basic indus-

trial material. Production could be greatly expanded with market needs.

The edible soy oil is subjected to various processes besides hydrogenation before consumption. Crude oil as it comes from the presses or extractor is freed from particles of meal by settling and filtration. It is refined usually with an alkali to produce a clear, light yellow, sparkling oil. Color is removed from the refined product by treating it with an absorbent material. It is hardened by hydrogenation. If intended for salad oil the hardening step is omitted. Finally it is treated with superheated steam in a high vacuum to produce a bland, colorless, almost tasteless product. The hardened fat is homogenized with purified air to produce the crystal white vegetable shortening whose container has begun to streamline the American kitchen.

The skill of technicians has eliminated serious problems in these processes. The art of refining and hydrogenating has gone swiftly forward.

It became clear that since soy oil could be hydrogenated it was competitive with cotton, peanut and other oils used in shortening. Some scientific work by processors and refiners made possible the use of 2 per cent of the output in shortening in 1933 and some viewed that as the saturation point. But a few determined chemists stayed at it. By 1939 more than 50 per cent of the nation's soy oil production was passing into shortening.

The story of salad oil is similar. Steady improvement in technique and refining equipment combined with constant laboratory work brought forth an excellent product for use in mayonnaise and salad dressing.

Step by step chemists added improvements that standardized and aided adaptation. A few edible oil users began

consuming in ever-increasing volume, reaping advantages in cost and quality. Others fell into line, some from necessity. A free open liquid market thus was created. Now there is always a ready buyer, though in some periods at a painfully low price.

A large producer of soybean oil at its four crushing plants in Illinois, Iowa and Ohio, Swift & Company also has been regarded as one of the largest if not the largest individual consumer of that product for distinctly edible purposes. Chemists of the company's food research laboratories devoted intensive work to the study of oil reversion and other problems. Such efforts, along with those in numerous other private and public laboratories, were a contribution to the scientific research and aided in broadening the field of soy oil in edible foods. Company statistics show that from 1934 to 1940 while production of soybeans was increasing in the ratio of ten to one, the corporation's usage of soy oil increased twenty to one in products siphoned into its nation-wide marketing system.

"And the potential use," said H. W. Galley, Staley oil expert, in a recent public address, "is far-reaching indeed. Current consumption figures are the key to the future."

A revealing incident on early resistance to the product is related by Adrian D. Joyce, president of The Glidden Company, a progressive and imaginative industrialist. Some years ago he instructed a subsidiary, Durkee Famous Foods, to consume in its products the edible soy oil produced that year by the parent company. There was a storm of protest. The idea was preposterous. But the chief was adamant.

"The next year," said Joyce, "our boys were complaining just as vociferously, but in another vein. They

argued we were not producing enough of that soy oil. They could use more." They have been using more each year.

All edible oils and fats in their pure state have about the same caloric value. Competition arises in large measure out of interchangeability. Take shortening. Several oils

### SOYBEAN OIL IMPORTED AND EXPORTED

YEAR	OIL IMPORTED (pounds)	DOMESTIC AND FOREIGN OIL EXPORTED (pounds)
1940	4,848,670	15,953,901
1939	4,125,526	12,110,936
1938	4,258,115	6,411,731
1937	29,752,024	5,747,680
1936	7,187,051	3,953,835
1935	14,248,574	4,111,188
1934	2,828,523	2,040,127
1933	3,669,048	1,569,030
1932	404,572	2,692,243
1931	4,916,253	5,448,494
1930	8,348,352	5,479,431
1929	19,489,129	8,096,492
1928	13,116,220	7,994,404
1927	14,914,792	6,628,648
1926	30,711,687	2,112,156
1925	19,492,900	2,267,211
1924	9,125,158	2,541,167
1923	41,679,110	1,528,316
1922	17,325,496	2,876,836
1921	17,282,967	2,454,466
1920	112,213,750	46,740,220
1919	195,808,421	*34,803,160
1918	335,984,000	
1917	264,926,000	
1916	145,409,000	
1915	21,335,000	
1914	12,555,000	
1913	14,221,000	
1912	24,959,000	

\* For 6 months beginning July 1.

SOURCE: Department of Commerce, Bureau of the Census.

can be used alternately by blending fats of varying consistencies for a combination that leads to the desired body. Factors watched are color, flavor, odor, stability, plasticity, creaming ability, and emulsifying power. The ultimate consumer is interested only in the product—not in the oils used.

Right now about twenty edible oils and fats are used for shortening. They are highly competitive, fluctuate in price. Today a manufacturer might be using cotton and peanut oils. Next month market conditions might indicate cotton and soy oils, with still another change the subsequent month. Such is the condition too with margarine.

It was into this competitive field that the bean had to bludgeon its way. Of course the market is broad. In normal times the nation needs some ten and a half billion pounds of oils and fats, of which we produce nearly nine billion pounds. Net imports total about one and a third billion pounds in peace times.

Consumption of fats and oils falls normally into three main channels. Less than three quarters goes into edible use, about a fifth into the soap kettle, less than a twelfth into drying industries, mainly paint and varnish, and a scattered remnant into miscellaneous items.

Of late years, prior to the second World War, lard has been the problem child. It has lost its export market, or a large part of it. In the last decade exports were but half the preceding decade. In former times exports took a full third of our lard. Now a good portion of that must find consumption at home. Whether the export lard market ever will be permanently regained is a question.

Lard cut into cottonseed oil. Soy cut into both.

Soy will doubtless continue to cut in. Farmers are going

to grow the beans, manufacturers are going to use the oil. Better oil producing types are being developed. An average dry Illini soybean contains about 20 per cent oil, 36 per cent protein, and 32 per cent carbohydrate material. The oil, pound for pound, has a greater monetary value than the other major product, soybean oil meal.

True, the market is immense, but so is the annual reservoir of oils and fats. Into this reservoir is being poured a broadening stream of soybean oil, which is further indisputable evidence that the versatile beans know how to make friends and influence people.

"Trade barriers" have been raised against margarine, a nutritious product, made almost wholly of American farm products by American labor. Eighteen states have enacted laws to levy excise taxes or license fees on makers, wholesalers and retailers. Excise taxes range from five to fifteen cents a pound, the latter in Wisconsin and Washington. The Pennsylvania grocer wishing to sell the product must pay a one hundred dollar annual license fee; a Montana grocer must pay four hundred dollars.

Various agricultural and commercial groups opposed to these taxes, which they characterize as trade barriers, declare that if they were removed annual consumption would increase to a billion pounds. Leaders of these groups argue, too, that this would not decrease butter sales, for margarine reaches a low-income class unable to buy butter. This class, it is asserted, includes millions of consumers whose present table spread is limited mostly to fat meat grease.

## SOYBEAN OIL

*Factory Consumption by Classes of Products \**

	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940†
Compounds and vegetable cooking fats	10,869	25,269	489	2,735	52,452	113,897	90,798	137,133	201,599	212,317
Oleomargarine	623	3	7	24	1,740	14,262	31,793	39,885	70,822	87,106
Other edible products	—	180	460	509	9,421	21,598	15,530	11,280	32,345	39,980
Soap	3,816	5,571	4,235	1,345	2,549	5,023	10,274	10,897	11,177	17,612
Paint and varnish	6,256	7,485	8,568	10,451	13,003	14,471	16,143	15,183	21,720	29,828
Linoleum and oilcloth	2,612	4,061	5,641	2,843	4,816	2,886	934	3,605	6,439	7,254
Printing ink	33	47	65	59	52	62	80	59	62	82
Miscellaneous	2,051	1,875	2,626	2,109	1,665	3,405	3,038	5,340	9,332	16,538
Foots and loss	1,625	1,158	867	823	5,468	8,959	9,926	14,046	16,265	20,924
Total	27,885	25,269	22,958	20,907	91,166	184,563	178,516	237,428	369,760	431,641

\* In thousands of pounds.

† Preliminary.

Source: Bureau of Census reports.

## CHAPTER 8

### IN THE FIELD OF INDUSTRY

Yes, the magic bean is versatile. Surprisingly so. One need but turn to the field of industrial uses for convincing proof. There the list of soy articles is long and stirs the fancy. So much so that the public has pictured the crop as flowing direct from the farm to the motor car factory, the plastic works, the novelty plant, or the shop that makes Christmas tree baubles. Hence the subject of industrial uses needs some clarification in the interest of accuracy.

In the early days the paint industry used a large part of the small total output of soybean oil. It still is a substantial user. For soy oil, refined just as linseed oil is refined, and treated with similar driers, pigments, and resins, makes excellent paints and varnishes. But care must be taken to use proper materials because of its slower drying characteristics. The U.S. Regional Soybean Industrial Products Laboratory, Urbana, Illinois, says soy oil may safely be substituted up to 25 per cent in most paint formulas.

A handicap has been the traditional demand in paint specifications for particular oils such as linseed and tung. The new tendency is to indicate, instead, performance of the protective coating. And this tendency has given soy oil a golden chance where permitted. In the Midwest, paint with soy oil has sold in millions of gallons.

The salvation of the entire industry may hinge in a measure upon complete solution in the laboratories of the

problem of a quick-drying soy oil for paints, which, incidentally, use half a billion pounds of various oils each year. Intense research is under way in government and private laboratories. A few straws now point the wind.

For example: In the search for substitutes for necessary foreign drying oils, we find the commercial application by Armour and Company of continuous fractional distillation to obtain synthetic drying oils from soybeans and other products. A molecular still was installed in which soybean oil is placed after glycerine is removed. In this still, based on difference in molecular weights, the saturated fatty acids are separated from the unsaturated. These saturated acids proceed to the soap kettle where they serve even better than the soy oil. The unsaturated fractions are claimed to be an extremely fine drying oil. Reported capacity here is fifteen million pounds annually. This is concrete, definite progress in the industrial oil end.

The government laboratory is studying a method for separation into two fractions, one for drying oil and one for edible purposes, based upon the action of selective solvents on soy oil.

So much for paint and the bright future promised.

There is a "success" story in the use of the bean by I. F. Laucks, head of the Seattle firm bearing his name. The plywood industry on the Pacific Coast had to find a new type of glue that would render the material water-resistant or risk loss of their big market to newer products. The outlook was dark.

But Chemist Laucks had the answer. He submitted it in 1923. Plywood had been made in the Northwest since 1907, but the now booming industry dates its rise from 1923. Today soybean glue is the standard adhesive for

pine and fir plywood. To visualize the industry, more than a billion square feet of plywood glued with soy is shipped to all parts of the world each year. Laucks has glue plants in Seattle, Portsmouth, Virginia, Vancouver, and in Stockholm to serve Europe. Licenses have been granted to other manufacturers.

The product performed a basic service. It provided a low cost water resistant adhesive free of violent price fluctuations. It enabled the industry to look ahead to low-price volume markets. Incidentally, it created new jobs for many workers.

Stories built around gadgets made of soybeans have caught the headlines. Yet the consumption for glue each year is many, many times that involved in all the baubles, buttons and the like produced in the past few years.

Scientists at the laboratories of The Glidden Company have carried forward fascinating projects. One freely discussed is the production of isolated soybean protein, or alpha protein. Just as others broke new trails in development of meal and oil, this company, at immense financial outlay and through years of dogged patience, bitter disappointments and occasional back-trailing for scientific precision, finally was rewarded with success. It was a basic scientific soybean development along original lines, and is so recognized. Almost nine years were devoted to the effort; first, in developing the process, then in evolving mechanical and chemical means to carry on the process in a small way, and then in full scale plant production for the isolation of soybean protein. It was one of the largest and longest operations undertaken by the company. Today alpha protein is a reality. It is produced on a commercial scale as an industrial raw material. It has a most en-

couraging future. But it will likely be many years before the company can recover the sum expended in the effort.

Today the product is sold competitively with similar products. In seeking outlets the industries studied included paper, paint, various coatings, rubber, linoleum, textile and leather.

A new sizing process was evolved which is used by more than fifty leading paper mills. Water paints are made from alpha protein as a binder. Growth of the water paint business has been steady. A majority of companies manufacturing insulating board now use alpha protein because it produces an inexpensive, durable and washable finish. This finish can be repainted with oil paints without difficulty and without flashing.

Use of the new product in the rubber field has grown to carload proportions. It is fine as a protective colloid. With linoleum it serves as an emulsifying agent for oils and as a backing primer over asphalt-coated felt. The leather industry likes alpha coating because of its behavior in formaldehyde. Use there is enlarging. If you note fewer runs in women's hose, remember that from alpha protein a process has been developed for the sizing of silk hosiery. Longer wear and easier washing result.

In the industrial field an increasing volume of soybean oil meal passes into the fertilizer market. In 1940 the total thus used was estimated at fifty thousand tons. Some experts look for this to increase gradually to two hundred thousand tons. The product is a fine source of organic nitrogen. It is widely used in mixed fertilizers. It is especially helpful on light soils for tobacco and vegetables in the Northeast and Southeast. Experiments prove its usefulness for lawns. It is also an excellent fertilizer for all

kinds of flowering plants. It is especially fine for roses, for growth and flower production.

The whole fertilizer industry consumes some seven million tons of various materials each year, so the outlook here is hopeful. Cost may be a controlling factor.

Lecithin is another soybean product used in the industrial field. Some of it passes into such industries as paint, textile, lubrication and leather, soap and mineral oils. One of the most interesting and important uses of lecithin is as a stabilizer in ethyl gasoline. It is an excellent vegetable coating which keeps chocolate bars, candies and other confections fresh and appetizing and imparts a delicious nutty flavor. It also is used with creosote in preserving wood. Action of lecithin in creosote prevents "bleeding" of preserved wood. In 1934 Archer-Daniels-Midland Company installed the first commercial lecithin plant in this country at Chicago. The Glidden Company also produces lecithin, and at this time is the only producer in this country of refined lecithin, utilizing a special process and plant developed for that purpose. Domestic production has far exceeded demand.

A score of various gadgets, horn buttons and the like, are made of soybeans and used on motor cars. It is publicity on this list that has given rise to the belief that the motor car industry consumes large volumes of the soy crop. This is a misconception. Up to 1942 such consumption has been very small based on the total crop.

Henry Ford is making a sincere effort to divert farm crops to industry. Splendid progress has been made in his laboratories. My brilliant friend, Robert Boyer, has gone far with such soybean research. But both Ford and Boyer would be quick to state that the company's actual con-

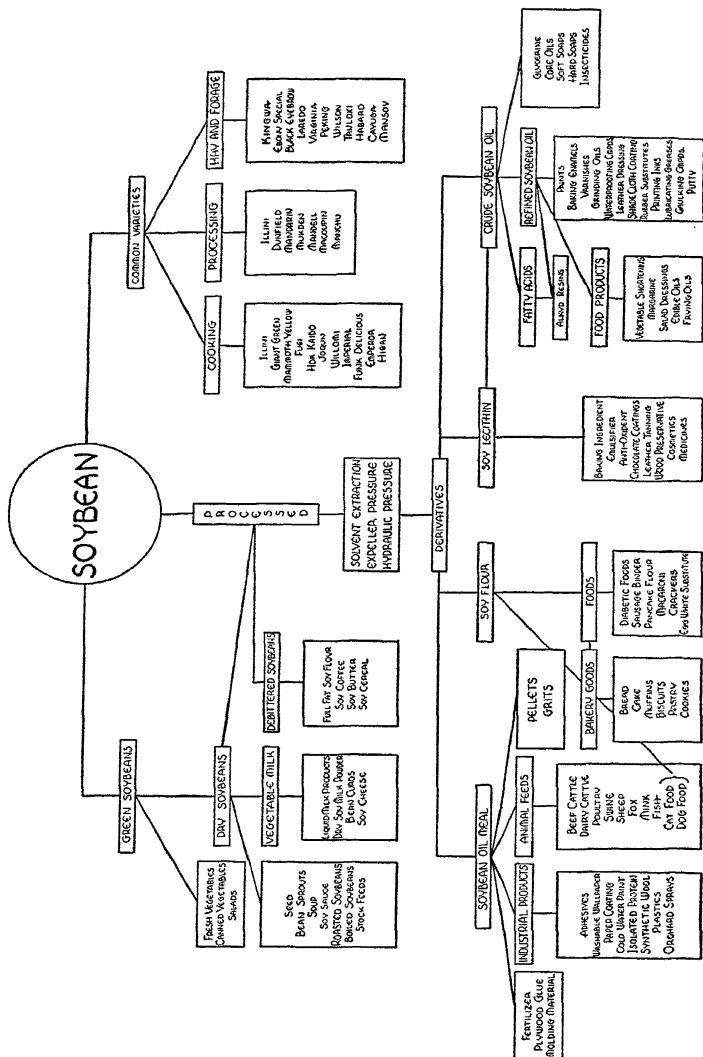
sumption of soybeans to date is of no consequence whatever upon a crop of from eighty million to one hundred and ten million bushels. They have been looking to the future.

A national magazine announced that Ford had authorized Chemist Boyer to order a complete set of dies for the first road model of a plastic automobile. It went on to list the volume of various farm products to be used, wheat, corn, soybeans, flax and the like, based on the annual production of a million plastic motor cars. Of soybeans, it was stated seven hundred thousand bushels would be required. To place such total in the proper perspective, remember it is equivalent only to the amount of beans processed for livestock feed and oil annually by one of the numerous small processing plants in Iowa, Illinois, Indiana or Ohio. There are plants of that small volume little known beyond their respective vicinities.

This is by way of clarification and is not intended to minimize the work being done at Dearborn. Ford, a great industrialist, is making a worthwhile effort in behalf of agriculture.

In aircraft manufacture a number of leaders are reported to be trying out the first airplane fuselages cast in one piece from soybean plastics. Here, too, we must await future results.

There are numerous other minor uses of soy in the industrial field. But again we return to an indisputable fact. It is that up to the spring of 1941 some 95 per cent of soybean oil meal manufactured has passed into livestock and poultry feeds, the remainder into industrial uses. Of the soy oil produced, from 80 to 85 per cent passes into edible products, the remainder into industrial uses. The



prevailing feeling is that the industrial field must be broadened if the farmer is to profitably continue expanding the crop.

New industrial uses are being found for numerous other farm crops. Progress can be credited to the driving force of the National Farm Chemurgic Council which merits the aid of all branches of business and industry. Its attainments shine out in the factual reports and addresses of President Wheeler McMillen, one of the brightest minds in agriculture.

## CHAPTER 9

### LISTENING POST FOR SOY

When a rumor wafted through the soy belt that Washington intended discontinuing work at the Soybean Industrial Products Laboratory at Urbana, Illinois, a storm broke loose. Farmers began protesting, the growers' society bristled, processors were indignant. A joint committee went to Washington, and was assured the rumor was baseless. Only then did the storm subside.

The incident was a striking testimonial to the excellent work of keen-minded men at the regional laboratory, one of those created under the Bankhead-Jones Act. Far from the program being curtailed, it now has been enlarged and housed in the huge Northern Regional Research Laboratory at Peoria, Illinois, where H. T. Herrick is director. The agronomic work was retained at Urbana.

Started in 1936 the program, broadly speaking, has sought to develop industrial uses for the soy and its products; to determine effects of various processes on quantity and quality of products obtained from the bean, and to provide facilities for testing quality of types for industrial uses.

It all sounds rather simple. But a day spent at the Peoria laboratory with the staff of scientists broadens one's perspective as to the magnitude of the efforts. Dr. O. E. May, later Dr. R. T. Milner and then T. H. Hopper headed the Urbana laboratory in its important earlier

work. Dr. Milner is now carrying on at Peoria. Reports on the research studies, unexciting to the layman, keep soybean scientists on the edge of their seats. Upon the work of J. L. Cartter, agronomist, and other staff members, thousands of growers pin faith for future heavy industrial uses of the soy.

The program carefully avoids conflict with or overlapping of work of other agencies. It was charted by farmers, processors, experiment stations of the twelve North Central States served, and by Department of Agriculture experts, and is reviewed annually by a collaborative board. Work on the growing soybean plant is under direction of the Bureau of Plant Industry, Washington, and chemical and engineering work under the Bureau of Agricultural Chemistry and Engineering, both divisions of the United States Department of Agriculture.

Illinois, heart of the soy belt, the State that had produced more than half the total crop, was the ideal location for the studies. In plant culture, the University of Illinois offered exceptional opportunities—facilities for greenhouses and experiment plots, easy availability to the big library, and contact with Burlison of the Agronomy staff, who has done so much in the study of oil and paints, and with Hackleman and a score of others. Facilities were provided to the government free by the University.

The general program follows two types of work. The first may be called practical or applied research. Examples are the production of plastics from soybean oil-free meal and the making of paints and varnishes from soybean oil. The second comprises theoretical and fundamental studies

on soybeans. In the future these may mean more than any results derived from the more practical studies.

Plastic articles are increasing in use because of cheapness and ease of quantity production. A practical molding powder has been developed from soybean oil-free meal, phenol formaldehyde resin, and wood flour. This cheap powder can be made in bright clear colors. It has a water absorption of only 0.6 percent after soaking for twenty-four hours. Industrial firms now are trying this and similar types of soy plastics.

A large commercial use of protein is the coating field. A finish coating for paper is made from a mixture of clay and protein. Intense interest has been aroused in the paper coating industry over the use of soybean protein to provide a stronger and cheaper coating. Protein coatings make a leather finish, and an aqueous dispersion of soybean protein with formaldehyde developed by the laboratory staff is being used commercially as a leather finish. The formaldehyde hardens the protein and make it more water resistant. This same dispersion has been used by the scientists to produce a laminated panel board. Sheets of paper, soaked in the dispersion, dried, stacked in a press and heated under pressure, are bound together by the protein to make a strong, tough laminated board. This material must be protected against water. It was found that single sheets of phenolic resin paper may be bonded to the faces in the press.

Several hundred paints and varnishes have been tested. Exposure and tests have proved that soybean oil is inherently a good oil in protective coatings. It has been found that the proper choice of resins, pigments, and driers is of high importance in obtaining good soybean oil

paints and varnishes. Both chemical and physical treatments have been used in attempting to improve the properties of soybean oil. The thickening of the oil when heated can be hastened by the addition of chemicals. Rapid drying fractions can be removed from the oil by the use of selective liquid solvents in the oil. The work definitely has stimulated interest in use of soybean oil for protective coatings.

At the end of 1942 the Peoria laboratory was producing in a pilot plant an artificial rubber, with a large soybean oil content, that gave high promise for certain uses. The government was closely guarding the secret formula.

The agronomic work has large potential future importance. Improved varieties are being obtained by breeding and by selections from foreign plant introductions. Varieties are being developed for new localities of growth. Data on composition and yields are gathered to guide growers and processors.

Not only are the two laboratories a listening post of the industry. They constitute a clearing house of new developments for growers, processors and research workers. They are performing a big task admirably.

## CHAPTER 10

### WHIMS AND PRICE TURMOIL

Stories of the soybean's might have been as fantastic and unreliable as war rumors out of the Balkans. In recent years some headlines have fascinated the layman and startled the expert. The general theme has been that here at last is a product which in any form will guarantee commercial fame and fortune. But to date the business of processing has had its share of aches and pains. The trail of wrecked hopes and lost funds on poorly financed projects stretches across the soy belt.

Processors were just getting back into stride after writing off previous losses when the second World War broke out in September, 1939. All commodity prices zoomed upward. Soybeans were a new speculative item that touched public fancy, and in the sensitive futures market the prices were soon whipping about like garments on a windy clothesline. The customary yardsticks of measuring business commitments were out. A crystal ball would have served as well. Processors had to fill the needs of customers to keep their hard-earned place in the field. Yet the price ceiling created by competitive products made their position an unenviable one. How much was lost before the debris of the autumn price cyclone was cleared away probably will never be known. But processors did buy to the last bushel offered and merchandised the products from the largest crop grown up to that difficult year.

During the public speculative whirl many absurd stories appeared in print. When reports of how Europe would take the entire crop had grown a bit cold other tales were flushed up. Here is a typical one. The newspapers suddenly bloomed with a headline that the crop would be used to make glycerine for war purposes. This was too much for one talented chemist in the laboratories of a processor. He knew it was not true. He knew the cost was prohibitive. He was plainly irked. Just as Brother Juniper, the red-headed monk, set out to determine the cause of the fall of the Bridge of San Luis Rey, this chemist vowed to run down the source of the glycerine yarn. So he asked one editor the origin of the story and readily was given the name of a news service. He inquired of the service and was told the article came from a newspaper receiving dispatches from the service. The chemist then sought out an editor of the newspaper named. Here he learned the story had come from a small-town correspondent in an adjoining state. The chemist was a determined fellow and finally got in touch with the correspondent, a young lady of vigor and imagination. After a few pleasantries he inquired:

"Where did you really get that story? I mean your authority for it?"

"I wrote it the other night," she replied. "I had been inquiring about the subject and the idea of glycerine came to me. So I went over to the library and searched around in books on chemistry. Sure enough I discovered I was right. Glycerine can be made of soybeans."

The chemist explained that glycerine could be obtained from many things—"even from the human body."

"But," she laughed, "you must admit it's easier to get beans than bodies."

Equally silly tales influencing market prices have emanated from important sources and from persons of sufficient standing to acquire space in thoughtful journals. Usually such persons were striving for effect by toying with possibilities, stressing the unusual and neglecting salient facts of a less colorful tinge. In some instances they just did not know what they were talking about.

In any case the sum total of such inaccuracies added to the instability of the industry and encouraged temporary price convulsions that in the aggregate proved injurious to the industry.

Schemers and dreamers have gloated over the curious tales and ballooned them into astonishing fables. Sometimes funds have been drawn from the gullible to carry out unsound projects.

Promoters still were busy in 1941 striving to raise money in various cities and towns to start new processing plants. The usual policy was to interest a local bank or a chamber of commerce. In many instances the effort was made in territories barren of soybean culture. In those cases the farmers were to be induced to grow the raw material for the proposed mill. Even sketchy inquiry would show that the products already were being laid down there at costs below those involved in the operation of a small promotional mill. Most of such attempts ended after preliminary funds were expended and before new plants arose.

The indisputable fact is that processing facilities available up to 1942 have been far in excess of the largest crop

grown. The further fact is that the merit of the soybean needs no exaggeration.

Let a story appear, as one did, saying that scientists at a government laboratory ran a diesel engine on soybean oil purely as an experiment, and a flood of hysterical inquiries reaches processors from those who have decided to make soybean fuel oil.

To ask one of these promoters a question is like twisting a fire hydrant. He will pour out a verbal stream of articles made of soybeans. But he will fail to mention that such uses represent a wholly insignificant part of the total crop. Little boys can make a wagon of four wobbly wheels and a cracker box, but such consumption has no influence on the box market. Motor car horn buttons and suchlike gadgets have meant next to nothing to the producer and the processor.

As Professor J. L. Norton of the University of Illinois has pointed out, to date the bulk of the crop has gone into soybean oil meal for livestock feed here and abroad, and into oil used largely in the edible field.

And even the feed field is competitive and crowded. In recent years total production of high protein feeds from oil seeds has increased sharply, and soybean oil meal is the chief newcomer.

In this table soybean oil meal represents little over 1 per cent of the total of the feeds listed. But mark well the fact that it constitutes about one-third of the oil feeds derived from oil seeds. Clearly four factors stand out:

Demand for the group of products must be fairly elastic or prices will drop sharply when supplies increase. Apparently it has been possible to increase use of high-

protein feeds because balanced rations mean greater economy.

The new soybean product must be equal or superior to the old products. This fact has become obvious.

It must be priced competitively. Indeed a new product must almost buy its way into the market.

And last, it must have aggressive merchandising, a constant forceful driving sales program. Such the processors have given the product and thus built the market for the farmer.

But during 1941 processors were still bedeviled by shifting price tides, by swift economic changes, by some price ceilings, and by a war-closed door to their export meal market.

This little table of supplies of feed in 1939 will give a quick comparison:

	Thousand tons	Per cent
Feed grains (1938-39)	112,000	91.73
Cereal by-products:		
Wheat meal products	4,925	4.03
Gluten feed	695	.57
Dried beet pulp	286	.23
Distillers and Brewers Dried grains	275	.22
Rice mill feeds	125	.10
Sub total	6,306	5.16
Oil cake and meals:		
Cottonseed	1,900	1.55
Soybean	1,275	1.04
Linseed	400	.32
Others	215	.17
Sub total	3,790	3.10
Total	122,096	100.00

## CHAPTER 11

### MILK FOR THE TOTS OF CHINA

A strike of milk-wagon drivers brings fear to American mothers. But in such a situation Chinese mothers would only smile. For the soybean has long been called the Cow of China. Children have been born and have grown up in the Orient without tasting milk other than that from soy. It has served admirably both from the standpoint of nutrition and economy.

Many interesting scientific tests have been made. One was based on costs for the first five months of a child's life. Fresh cow's milk on the Shanghai market cost twenty dollars a month in local currency. American prepared baby foods cost twenty-six dollars a month. Other local and imported foods ranged from twelve dollars to sixteen dollars a month. But for soybean milk the mother dipped into the family purse for only five dollars a month.

The *China Medical Journal* of May, 1937, published tests of comparative values of soy milk, cow's milk and imported baby foods. In all of several hundred cases the soy milk was rapidly digested and the children, ranging from bassinet to romper age, showed splendid symmetrical growth and marked muscular development. The report stressed the fact that in cases of digestive or malnutrition problems the nutritive value of the soy protein was most helpful. Not having acquired tastes, most infants anywhere will readily accept soy milk.

This milk is a colloid liquid. From it can be made a lactic acid milk or cheese. In the Orient the soy is not used so much as a vegetable as in the making of such dishes as cheese, sauce, breads, meat substitutes and the like. Soybean curd or cheese is a common food, even marketed in American cities of large oriental populations.

Dr. E. A. Ruddiman of the Ford Motor Company Research Laboratories sees possibilities for the milk in this country, particularly as a curative agent. Physicians now prescribe it for certain disorders.

Soybeans in human diet are ages old in the Orient. Local consumption as food in some districts runs up to 90 per cent. From Manchuria to the south of China, in Korea, Japan and the Malay Peninsula it has been the basic protein food for thousands of years.

Scientific studies say the soybean contains vitamins in very substantial quantity, and is an especially valuable source of vitamin B. The Bureau of Science, Manila, says it is necessary in balancing the Philippine diet because of B vitamin. There is said to be an absence of the dreaded beriberi and pellagra where the soybean is plentifully used.

The able Dr. Harry W. Miller, International Nutrition Laboratory, in his oriental studies lauds this readily acceptable type of protein food. It is, he declares, secured in pure form free of the products of putrefaction as found in animal protein. Compared with other common edibles it can be classed as a pure unadulterated food, uncontaminated by waste material or disease.

As an economical source of protein, it is asserted the soybean has no peer. This seems to be proved beyond doubt in published comparisons with proteins as food from milk, eggs, fish and meat.

Germany, France and England have added soy to the diet, and some European observers say it is not unlikely that the war will bring the food value of the product forward with such impact as to gain permanence. Time will tell.

With our own abundance of foodstuffs, the courageous comments of nutrition experts in this country on the soybean's food value mostly have been like cries in the wilderness. But there are certain portents. Physicians are stressing the fact that the soy contains the essential groups of amino acids, that it is a complete protein that satisfies all need for human protein metabolism when properly processed. Carbohydrate content is low. The bean is practically starch free, thus highly desirable for diabetic or obese persons. Mineral content ranks high, containing a supply of phosphorus in the form of lecithin and cephalin which nourish the brain and nerve cells. Its alkaline ash builds great resistance to disease and infection. Thus do the scientists sum up the immigrant bean, and continue:

Two-thirds of the body weight is muscle, made largely of protein. Nerves and glandular tissues are protein to goodly portion. In their functioning the digestive organs and hormones are influenced by protein. Hence, it is explained, orientals turn to soy to relieve fatigue; it has given coolies the strength for man-killing toil.

Studies have indicated that in event of a food shortage by reason of drought, war or devastating epidemic in the animal kingdom, life in this country could be safely sustained by substituting soy protein for animal protein foods and without physical discomforts.

In the Orient where soy cooking is a fine art, the versatile bean produces endless appetizing dishes that appeal

equally to the eye and the palate. Incidentally, a complete soy banquet was served recently at Iowa State College. There were soy cream soup, wafers, sprout salad, soy mayonnaise, soyburgers, noodles, muffins, butter, coffee, and soy sherbet and cake for dessert. Doubtless the dinner could have been improved with a thick, tender steak, but the banqueters survived with enthusiasm.

Soy sauce, used chiefly on such foods as chop suey and cold meats, and long imported from the Orient, is now made in this country, shipped out in tank cars, and praised for its excellence.

"The more I work with the soybean," says Dr. Miller, "the more I am struck by the broadening opportunity offered in the food field. The forward sweep will start when the nation becomes aroused to the value of the soybean in our dietary."

## CHAPTER 12

### SOYS IN THE HOME GARDEN

When living costs begin to pinch free-spending Americans the backyards of millions of urban-dwellers are transformed into miniature vegetable farms. During the period of high food prices incident to the first World War the small home garden attained popularity. There were garden clubs and, in some cities, large community gardens presided over by instructors.

If the second World War is a long one the vegetable soybean for table use is expected to make its initial appearance in home gardens of many states. It might even have considerable influence upon the nation's diet.

In the food division of the general war program the soybean holds a place of importance. Its position had been established even before Japan's sneak blow upon Pearl Harbor, for an ample supply of fats and oils is an essential part of any war-time program.

Many months before our entrance into the conflict the government studied plans for increasing soybean production. It was realized that war with Japan would stop imports of oriental vegetable oils. So the United States Department of Agriculture asked farmers to increase the 1942 planted area to seven million acres or one million acres more than in 1941 and twice the 1936-40 average. Later the government asked that the farmers increase the 1942 planted area to nine million acres. This would an-

ticipate a 1942 \* crop of one hundred and fifty-three million bushels.

"And such a total," commented a Washington authority, "may be only a preview of subsequent crops should the war be extended for several years."

While the average individual will consume more soybeans in the form of soy flour and soybean oil in various products, his easy and direct contact with the legume would be found in home gardening.

Progress of the garden varieties of soybeans has been encouraging. The vegetable type was unknown in this country until Explorer Bill Morse planted the imported varieties at Arlington Experiment Station. In 1934 seed from these plantings was distributed to a number of agricultural experiment stations. The work of testing for performance and palatability was begun by state agricultural experiment stations in Illinois, Indiana, Ohio and Iowa. Funk Bros. Seed Co. did constructive research work.

At the University of Illinois the Home Economics Department ran palatability tests on four hundred and sixty-six varieties. Eighteen were designated as excellent. A bulletin (No. 453 Illinois Agricultural Experiment Station, Urbana, Illinois) was published on results. Shortly interest was widespread, with three thousand requests for seed from all states, Hawaii and seven foreign countries.

To test the desirability of the vegetable soybean in the home garden, the University of Illinois later distributed free samples of seed to a list of responsible people. At the end of the 1939 season reports were received from eight hundred and ten persons to whom seed had been furnished that spring. Eighty per cent reported success in the pro-

\* Late 1942 government reports show 10,867,000 acres and 209,953,000 bushels for the 1942 crop.

duction of the crop despite drought, grasshoppers, rabbits and other hazards. Seventy per cent were enthusiastic about the product's table quality as a green vegetable.

Professor J. W. Lloyd of the University of Illinois says: "When we consider that most housewives had had no previous experience in cooking this new product, and that with many persons the relish for soybeans develops gradually, this is a rather high percentage of acceptability at an early stage of introduction."

Favorable experiments were carried on at various state institutions. Results indicated the desirability of using the vegetable type of soybeans in such institutions during winter months rather than as green vegetables during the late summer and early fall. State institutions in Missouri are credited with being first in determining the advantages of this policy. While no scientific medical data is available, it is interesting to note that some of these institutions caring for persons afflicted with mental disorders reported a quieting effect when edible soybeans and soy flour became a substantial part of the diet.

Seed of the vegetable type was difficult for the public to obtain until early 1940. Now seed is featured in a number of catalogs. A list of growers may be obtained upon request from state universities in the soy belt.

Professor K. E. Beeson, Purdue University, sums up vegetable soybeans in this way:

"Compared with navy and lima beans on a dry, mature basis they possess about one and one-half times as much protein, twelve times as much fat, and about one-half the carbohydrate content, and considerably more minerals, particularly calcium and iron. Value as human food is attested by age-long use in the Orient."

They have an alkaline ash, are rich in lecithin, and have

## SOYBEANS

a high vitamin content rating. Freedom from starch makes them a desirable dish for diabetics. They rank high as a non-fattening food and appeal to those seeking to reduce weight.

Edible varieties differ as much in palatability from the common commercial field varieties as does Golden Bantam corn from ordinary field corn.

The edible strains will grow on any soil and under any conditions which will produce other varieties of garden beans. The yield of soybeans, however, is very much heavier. Immunity from insect and other damage is pronounced.

There are several promising edible types with a varied range of maturity of from eighty to one hundred and thirty days. For home gardens three or four varieties of different lengths of maturity should be planted to provide green soybeans over a continuous period. Of these varieties, Bansei, No. 80494, and Fuji are early. Willomi, Hokkaido, Aoda, Jogun, and No. 80490-1 are mid-season. Illington, Imperial, Funk Delicious, Emperor, and Higan are late.

For planting small areas in home or market gardens a regular garden seed drill has proved quite satisfactory. Adjustments are readily made to accommodate different-sized seeds of the varieties of table-type beans. In the absence of any seeding equipment, small test plots of seeds, or a row or two in a home garden, may be planted by hand in drills made with a hose just as garden peas are planted under similar conditions. It has been found that a minimum space of two feet between rows is needed for handling the crop whether grown for green shell beans or mature seed. A rate of planting that will place the seeds

from one to two inches apart in the row has been found to be more satisfactory if an ample seed supply is available.

It would be difficult as yet to determine the most desirable varieties of vegetable soybeans. In a general way, for the extreme North the Sioux, Agate, and Green Giant are most suitable. For the Corn Belt or middle section of the country the Hokkaido, Kanro, and Aoda are recommended. For the South the Nanda, Seminole, and Rokusun.

For use as a green vegetable, or for canning, the pods should be picked before the soys have reached full size and before there is any tendency to turn yellow. When too ripe the beans have lost much of their tenderness. Pods can be shelled easily if placed in boiling water for one minute. Incidentally, some ingenious housewives reported to experiment stations that they had evaded the task of shelling garden soys by hand. They simply adopted the oriental method. This means cooking the beans in the pod and letting each guest do his own shelling. It adds a leisurely touch to the luncheon or dinner. The fingering is no more objectionable than that involved in eating a burr artichoke salad.

When cooked as a green vegetable a pressure cooker should be used. Most of the varieties thus may be cooked in from ten to fifteen minutes. Much longer time is required in an open container.

Green vegetable soys may be prepared in the same manner as other garden beans, including lima and navy beans. Portions served at the dinner table are smaller than the usual vegetable helping because of the rich food value. Vegetable soybeans frequently are used to fortify other dishes or other vegetables. They are listed as an excellent

addition to ordinary soup, chili con carne and similar dishes. They are an ingredient for many salads, lifting the food value substantially. Mixed with corn they make a delicious succotash.

Commercial canning of soybeans has been somewhat delayed by the absence of large commercial seed supplies. Adverse weather conditions in the 1941 autumn harvesting season did not help the commercial canner.

In the directory of the National Cannery Association, 1940 edition, ten companies are listed as canners of vegetable soybeans. An association was organized, with the head of one of these companies, W. L. Schroeder, Hortonville, Wisconsin, as president. Up to 1940 the largest annual production of a single canning company was eight carloads.

Wisconsin has shown considerable leadership under the scientific direction of Professor G. M. Briggs, University of Wisconsin, in the development and the actual marketing of vegetable soys. Dr. J. B. Park of Ohio State University has carried on highly important research work. It is unfortunate that more of the findings have not been published.

A relatively small number of the vegetable type variety is well adapted to canning. Experience still is so limited that there is some disagreement among the experts. However, promising varieties for canning include the Aoda, Bansei, Funk Delicious, Rokusun, and Willomi.

Ford Motor Company was reported to have planted enough acreage of the Bansei variety to yield about two hundred thousand cans of green vegetable soys in 1941. The entire pack was to be used in the company commissary and stores.

Experimental work in canning and freezing of green soybeans is going forward at several state agricultural experiment stations. Early tests indicate frozen soys are satisfactory from the standpoint of color, texture and flavor.

It is likely canning or freezing of the green soys will develop first on a large commercial scale only in localities where green peas are already grown as a cannery crop and where vining machinery is available.

## CHAPTER 13

### AMERICANIZING SOY FOODS

Oriental require a number of years to acquaint themselves with the American language, manners and habits. As a basic oriental food the soybean has likewise required years to adapt itself to the American palate and domestic cooking methods. It has a peculiar oriental flavor, highly acceptable to a population used to it from birth, but at first strange to most Americans. Its tremendous protein value is not yet fully comprehended by those who think of beans and peas as "vegetables."

This newcomer got off to a bad start in the first World War. In the patriotic days of food substitutes a scientific but misguided person ground whole soybeans into a flour and ballyhooed it as another substitute in breadstuffs. Some dietary authorities deemed the penetrating flavors so terrible that they turned thumbs down on soybeans as a food. There the matter stood.

But later it cropped up again. The first major step in Americanizing soy flour was to remove the penetrating "beany" flavor. This was done by grinding beans into flour or grits and processing with heat and vapors to carry off the odors and leave the mild nutty flavor of the protein intact. With hulls and bad flavor removed, soy flour emerged as the first and most important American soybean food. Milled in a preliminary way in 1926 and sold as a health flour, it was proved by 1935 to be a truly accept-

able product for many varied dietary uses. The husky infant has grown from an annual volume of some twenty-five million pounds preceding 1940 to about one hundred million pounds in 1942 and appears to be only getting in stride.

Health food products include endless adaptations of soy flour. There are many factual, convincing talking points. Bread having full energy value but no fattening effects and no contribution to stomach acidity is made from soy flour. Its excellence is praised especially by diabetics.

For various reasons some persons avoid meat. Zealous food faddists have pounded the drums for a meatless diet. A highly digestible protein not of animal origin, soy flour and soybean products moved smoothly into the health food specialty field.

Scientific dietary authorities are familiar with the facts. But the American public has not yet comprehended the full significance of this large new protein supply. The 1942 crop of approximately two hundred million bushels would mean thirty or thirty-five pounds of pure protein per capita for each person in the United States, a protein practically equal in food value to protein from meat or eggs. Protein derived from meat in the United States equals about twenty pounds per capita.

Perhaps the word "flour" has been confusing. Flour seems to mean bread and bread means carbohydrate or energy food to the public. Actually soy flour is a protein concentrate.

The baking industry constantly has increased its use of soy flour to intensify the nutty flavor of products and to longer maintain moisture and defer staleness. Tempera-

tures commonly used in the baking industry are splendid for bringing out the best flavor of soy flour and protecting nutritional value. The incomplete proteins of wheat bread when supplemented by a percentage of soy flour not only add the protein of the soy flour but mobilize all the wheat protein as well, as was strikingly demonstrated in experiments by Dr. D. Breese Jones, U. S. Department of Agriculture.

Soy flour has been used in large quantities in sausage, meat loaves and other products in which starchy cereals of no protein value previously had been the leading components. By use of soy flour the meat packer may greatly increase the protein value of his product.

Substantial quantities of soy flour have been used in the manufacture of dog food, both of the dry kibbles type and products canned with meat. Tests through generations of dogs have proved such a diet almost ideal. These exhaustive tests have contributed toward an understanding of the effect of soy flour in human nutrition.

Soy flour is used extensively in the confectionery industry. It aids in emulsification of the fats and prevents drying out of the finished candy. It is used to retain freshness and an added flavor in sweet goods such as cakes, pie dough and doughnuts. It has been included in noodles and spaghetti to give a high protein content so that cheese and meat need not be added for adequate protein.

Allusion was made earlier to use of the soybean by the German army. Performance of the army in the early stages of the current war focused added attention on soy flour. For three or four years before launching hostilities Germany had been storing soybeans. Thus she had assured herself of a reserve supply of highly digestible and non-

perishable proteins before starting the campaigns. Considering the vulnerability in food of the Central Powers, some commentators have ascribed almost as much significance to the German supply of soybeans as to her supply of airplanes. Soy flour and similar soy products are used throughout the German army rations. They are used with sausage and meat to extend the protein value of meat. They are used in bread to increase the protein supply. The field kitchens started into the war with more than two hundred soy recipes.

The British were not slow to comprehend. They made prompt requests for Lend-Lease soy flour from the United States and began to incorporate it in greater quantities in their domestic bakery products, confections and meats with larger percentages added to sausage. American meat packers provided sausage for the British army containing twenty percent of soy flour or grits to increase the protein content in the can and prevent the loss of fats fried away. Soy flour was used in soups or other dishes in British communal kitchens.

The U. S. Army first incorporated soy flour in the concentrated biscuit in the K-ration, then shipped quantities of soy flour to meet emergency protein shortages, and have conducted extensive experiments with meat and other products to provide more protein for our armies.

Public school lunches in the United States have been provided with soups based on soybean protein with many varied flavors. Concentrated cereals have been provided for schools and for foreign use. Soy macaroni has received much attention. Many additional uses were being prepared for the emergency.

Aside from the protein and energy values of soy flour

it is high in mineral content. It is the cheapest source of calcium of any food product obtainable. It has a very liberal content of all of the leading vitamins and apparently a heavy concentration of the entire vitamin B complex which is found elsewhere in major food items only in pork and other meats.

Manufacturers of soy flour are Allied Mills, Inc., Chicago, Illinois, Archer-Daniels-Midland Company, Minneapolis, Minnesota, Central Soya Company, Inc., Fort Wayne, Indiana, The Glidden Company, Chicago, Illinois, I. F. Laucks, Inc., Portsmouth, Virginia, Spencer Kellogg and Sons, Inc., Decatur, Illinois, and A. E. Staley Manufacturing Company, Decatur, Illinois.

China has always been somewhat of a riddle. Several hundred million people have sustained life—even granting a low living standard—on soil that is far from the best. The answer is found in this amazing concentration of protein on a limited acreage.

Soy flour will attain peak importance when Americans fully realize its significance as a protein food. With all our wealth of food supply, immense numbers are yet undernourished in protein, in calcium and in other minerals and in vitamins.

Soy flour is rehearsing a new and tremendous role.

## CHAPTER 14

### LITTLE BEAN, WHAT NOW?

Since the Neolithic stage of culture when men scratched the soil with polished stone implements, and plants and seeds came into use, the whole history of mankind has been brightened or darkened in almost exact ratio to progress in agriculture.

In no long period of time since the dawn of civilization have abundant food supplies been spread evenly over the face of the earth.

Wars of conquest have been fought to attain fertile, well-watered plains, plateaus and valleys. The specter of starvation has marched down the dim corridors of time, striking fear, hatred and greed into the hearts of races. Devastating famines of the present century have been a grim reminder that the riddle of a continuous food supply is still unsolved.

Of all nations, perhaps America alone has least to fear. Her vastness, the fertility of her lands, scientific production methods, modern power machinery, hard roads, superb transportation facilities and the high literacy of her farmers give her unchallenged world leadership. Her food productive capacity is elastic and could be stretched to an astonishing degree, a degree sufficient to feed a majority of all human beings on the earth's surface.

It may be too much to hope that in the post-war readjustment it will be recognized that America is a natural

market basket for many nations of the world whose lands do not lend themselves normally and easily to the production of those basic crops of which we produce lush surpluses. Acceptance of such a fundamental fact might contribute a great deal toward lightening the stress and strain among nations.

It has been clearly established that the oriental bean prospers and flourishes in American soil and climate. Here it produces superior products, due to superior methods of culture and manufacture. It is conceivable that these products in great volume later on may be siphoned into the export trade and, moreover, that consumption here, both as food and feed, may vastly alter the agricultural pattern.

But right now we know only that the versatile bean is unpredictable and that its record is replete with surprises.

One surprise was its speedy ascendancy as a major crop through the personal initiative of a comparatively small group of Americans with faith and courage.

There they stand—the agricultural explorers, the pioneer growers, the plant scientists, the processors, the brilliant men of the test tubes. All are like beads on a string.

They contributed to a cause and created a new industry, an industry that has brought substance to the dream of Charles Vancouver Piper who likened the miracle bean to “gold from the soil.”

## CHRONOLOGY OF THE SOYBEAN \*

- 2838 (B.C.)—The first written record of the soybean is contained in a "Materia Medica" describing the plants of China, written by Emperor Shen Nung.
- 1712—Soybean first made known to Europeans by Engelbert Kaempfer, a German botanist who spent the two years 1691 and 1692 in Japan.
- 1737—Linnaeus described the soybean in "Hortus Cliffortianus" from plants grown at Harticamp, Holland.
- 1739—Seed of soybeans received from French missionaries in China at the Jardin des Plantes, Paris, France.
- 1753—Botanical names *Phaseolus Max* and *Dolichos soja* first applied to the soybean plant by Linnaeus.
- 1790—Soybean first grown as a botanical curiosity in the Royal Botanic Gardens, Kew, England.
- 1804—James Mease in the first mention of the soybean in American literature states that the soybean is adapted to Pennsylvania and should be cultivated.
- 1829—A brown-seeded variety of the soybean grown in the Botanic Garden, Cambridge, Mass.
- 1854—The Admiral Perry expedition brought back two varieties of soybeans from Japan which were distributed by the U.S. Commissioner of Patents.
- 1875—Professor Friedrich Haberlandt began experiments with nineteen varieties of soybeans at Vienna, Austria.

\* Prepared by Division of Forage Crops and Diseases, Bureau of Plant Industry, U.S.D.A.

- 1878—Mr. James Neilson, New Jersey Agricultural Experiment Station, New Brunswick, N.J., obtained seed of several varieties of soybeans from Vienna, Austria, and began culture of the crop in 1879.
- 1889—Professor W. P. Brooks, Massachusetts Agricultural Experiment Station, Amherst, Mass., brought from Japan a number of soybean varieties, including the Guelph (Medium Green) and the Ito San.
- 1890—Professor C. C. Georgeson secured three lots of soybeans from Japan which were grown at the Kansas Agricultural Experiment Station, Manhattan, Kans., in 1890.
- 1898—The U.S. Department of Agriculture began the introduction of numerous varieties of soybeans from oriental and European countries.
- 1908—Beginning of the soybean oil and oil meal industry in Europe by English mills at Hull, England.
- 1910—Imported Manchurian soybeans first utilized for the production of oil and meal in the United States by an oil mill on the Pacific Coast.
- 1915—The first production of soybean oil and oil meal from domestic grown seed by a cottonseed oil mill, using an expeller press, at Elizabeth City, N.C.
- 1918—Record importation of soybean oil (336,000,000 lb.) from the Orient as a result of the general World War shortage of fats and oils.
- 1920—First processing of domestic soybeans in the Corn Belt by a linseed oil mill (expeller process) in Chicago Heights, Ill.
- 1925-26—U.S. Department of Agriculture secured more than two thousand introductions of soybeans from North China and Manchuria.
- 1928-29—Twenty-one thousand tons of soybean oil meal produced from domestic seed in the United States.

- 1929-31—U.S. Department of Agriculture obtained five thousand introductions of soybeans through agricultural explorations in Japan, Manchuria and China.
- 1931—First large exportation (2,161,000 bu.) of American-grown soybeans to European oil mills.
- 1935—Six hundred thousand tons of soybean oil meal from domestic seed produced in the United States.
- 1936—United States Regional Soybean Industrial Products Laboratory cooperating with twelve North Central States established at the University of Illinois, Urbana, Ill.
- 1939—Record production of soybeans (91,272,000 bu.) placing the United States next to China and Manchuria in world productions.
- 1939-40—Nearly twelve million bushels of domestic grown seed exported to European oil mills.



## BIBLIOGRAPHY

- Agnoli, R., and Untersteiner, L., "Vitamin A and B content of lentil, oat and soya bean meal," *Quad. Nutrizione*, vol. 3 (1936), p. 44. (*Nutrition Abstracts & Reviews*, vol. 6, p. 56.)
- Almquist, H. J., and Stokstad, E. L. R., "Assay procedure for vitamin K (anti-hemorrhagic vitamin)," *J. Nutrition*, vol. 14 (1937), p. 235.
- Anonymous, "Soya flour," *Food Manufacture*, vol. 4 (1929), p. 35.
- Armstrong, H. F., "The story of soybean glue," *Proc. 4th. An. Chemurgic Conference*, 1938.
- Baernstein, H. D., "The determination of methionine in proteins," *J. Biol. Chem.*, vol. 97 (1932), p. 663.
- Bailey, L. H., Capen, R. G., and LeClerc, J. A., "The composition and characteristics of soybeans, soybean flour, and soybean bread," *Cereal Chem.*, vol. 12 (1935), p. 441.
- Baughman, W. F., and Jamieson, G. S., "The chemical composition of soybean oil," *J. Am. Chem. Soc.*, vol. 44 (1922), p. 2947.
- Beaumont, A. B., and Stitt, R. E., "Soybeans for Massachusetts," *Mass. Agr. Expt. Station Bull.* 309, May, 1934.
- Bollman, H., "Process of obtaining lecithin from vegetable raw materials," *U.S. Patent* 1,464,557, 1923.
- Borst, H. L., and Thatcher, L. E., "Life, history and compo-

\* Prepared by Lamar Kishlar, member Soybean Nutritional Research Council, a group of scientific men who have contributed largely to research and compilation of literature on the subject.

- sition of the soybean plant," *Ohio Agr. Expt. Sta. Bull.* 494, 1931, p. 88. (*Chem. Abs.*, vol. 26, p. 5375.)
- Bowden, A., "Use of soybean meal for adhesive purposes," *Oil and Soap*, vol. 14 (1937), p. 114.
- Bowdidge, E., "The soya bean: its history, cultivation [in England] and uses" (Humphrey Milford), *Nutr. Abstr. Reviews*, vol. 5 (1935), p. 565.
- Boyer, R. A., "Progress report on the industrial utilization of soybeans," *Proc. 4th An. Chemurgic Conference*, 1938.
- Breedlove, L. B., "The soybean," *Chicago Journal of Commerce*, June 4, 1936, p. 12.
- Brown, B. A., and Slate, Jr., W. L., "Soy beans in Connecticut," *Storrs Agricultural Experiment Station, Bull.* 129, June, 1925.
- Bull, Sleeter, Carroll, W. E., Olson, F. C., Hunt, G. E., and Longwell, J. H., "Effect of soybeans and soybean oil meal on quality of pork." *Ill. Agr. Expt. Sta. Bull.* 366, April, 1931.
- Burlison, W. L., "The soybean, a plant immigrant, makes good," *Ind. & Eng. Chem.*, vol. 28 (1936), p. 772.
- Burlison, W. L., "The soybean," *Ind. Eng. Chem.*, vol. 28 (1936), pp. 772-7. (*Chem. Abs.*, vol. 30, pp. 306, 5321.)
- Burlison, W. L., "Recent developments in the utilization of soybean oil in paint," *Illinois Station Circular* 438, 1935, pp. 3-8. (*Chem. Abs.*, vol. 30, p. 306.)
- Burlison, W. L., "Utilization of soybean oil with special reference to paint," *Proc. 15 An. meeting American Soybean Association*, 1935, pp. 12-15-17. (*Chem. Abs.*, vol. 30, p. 306 and *Chem. Abs.*, vol. 31, p. 4513.)
- Burr, G. O., Burr, M. M., and Miller, E. S., "On the fatty acids essential in nutrition," *J. Biol. Chem.*, vol. 97 (1932), p. 1.
- Byerly, T. C., Titus, H. W., Ellis, N. R., and Nestler, R. B., "Effects of light, soybean, and other diet supplements on

- seasonable hatchability and egg production," *Poultry Sci.*, vol. 16 (1937), p. 322.
- Cartter, J. L., "Some commercial uses of the soybean," *Proc. Am. Soybean Assoc.*, vol. 11 (1928-29), p. 44.
- Cartter, J. L., and Milner, R. T., "Work of the agronomic and analytical divisions of the U.S. regional soybean industrial products laboratory," *Proc. of the American Soybean Association*, 1937, p. 12.
- Casberg, C. H., and Schubert, C. E., "An investigation of the suitability of soybean oil for core oil," *Univ. Ill. Eng. Expt. Sta. Bull.* 235, 1931.
- Chase, H., "More plastic parts with soya beans play an important role to tune of 1000 pounds daily at the River Rouge Ford plant. Metal parts in Ford line supplanted by molded plastics," *Automotive Ind.*, vol. 74 (1936).
- Church, Margaret B., "Soy and related fermentations," *U.S.D.A. Department Bull.* 1152, May 12, 1923.
- Churchill, F. G., "The soybean, an annual legume," *Iowa Agr. Expt. Sta. Bull.* 68, Mar., 1919.
- Cook, A. S., "Feeding experiment, soybean meal vs. cottonseed meal," *N.J. Agr. Expt. Sta. Report*, 1913, p. 293.
- Culbertson, C. C., Hammond, W. E., and Beard, F. J., "Linseed oilmeal, tankages, and soybean oilmeals for fattening steer calves," *Iowa Agr. Expt. Sta. Leaflet* 151.
- Culbertson, C. C., and Hammond, W. E., "Fattening steer calves; protein supplements; limited grain allowance; finishing steers in dry lot and on pasture," *Iowa Agr. Expt. Sta. Leaflet* 144.
- Cruz, A. O., and West, A., "Composition of Philippine soybeans and soybean oil," *Philippine J. Sci.*, vol. 48 (1932), p. 77. (*Chem. Abs.*, vol. 26, 1932, col. 3688.)
- Csonka, F. A., and Jones, D. B., "The cystine, tryptophane, and tyrosine content of the soybean," *J. Agr. Res.*, vol. 49 (1934), p. 279.

- Csonka, F. A., and Jones, D. B., "Differences in the amino acid content of the chief protein (glycinin) from seeds of several varieties of soybean," *J. Agr. Res.*, vol. 46 (1933), p. 51.
- Deming, Macey F., "Soybeans for human food," *Proc. Am. Soybean Assoc.*, vol. 1 (1925-27), p. 71.
- Dickey, J. B. R., "Soybeans in Pennsylvania," *Pa. State Agr. Expt. Station Leaflet* 36, Nov., 1935.
- Dimmock, F., and Kirk, L. E., "Soybeans," *Canadian Dept. Agr. Pamphlet* 155—New Series, 1934.
- Dollear, G. F., Kruaczunas, P., and Markley, K. S., "Composition of a soybean oil of abnormally low iodine number," *Oil and Soap*, vol. 17, No. 6 (1940), p. 120.
- Drake-Law, H., "The properties of processed soya," *Food*, vol. 5 (1936), p. 269. (*Chem. Abs.*, vol. 30, col. 4229.)
- Durkee, M. M., "Soybean oil in the food industry," *Indus. Eng. Chem.*, vol. 28, 1936, pp. 898-903. (*Nutri. Absts. Rev.*, vol. 6, p. 603.)
- Eisenschiml, Otto, "Domestic soybean oil, its history and its properties," *Paint Oil and Chemical Review*, Mar. 21, 1929, p. 12.
- Engelmann, F. T., "Process for the production of stable water-containing emulsions of vegetable lecithin," *U.S. Patent* 1,972,764, 1934.
- Etheridge, W. C., Helm, C. A., and King, B. M., "A classification of soybeans," *Mo. Agr. Expt. Sta. Bull.* 131, Dec., 1929.
- Fairchild, L. H., and Wilbur, J. W., "Soybean oil meal and ground soybeans as protein supplements in the dairy ration," *Purdue University Agr. Expt. Sta. Bull.* 289, 1924.
- Ferree, C. J., and Tussaud, J. T., "The soya bean and the new soya flour" (Wm. Heinemann Medical Books, Ltd., 1929).

- Field, Ada M., Alexander, Beulah H., and Sylvanus, Ethel B., "Soybean paste as an emulsifying agent," *Science*, vol. 77 (1933), p. 91.
- Frey, C. N., Schultz, A. S., and Light, R. F., "The effect of active soybean on vitamin A," *Ind. & Eng. Chem.*, vol. 28 (1936), p. 1254.
- Gerlaugh, P., "Soybean oil meal for livestock," *Flour and Feed*, Jan., 1936.
- Gilchrist, D. A., "Soybeans and soy cakes," *Mark Lane Express* 100, No. 4054, p. 667. (Reported in *E.S.R.*, vol. 21, 1909, p. 474.)
- Gray, G. D., "All about the soybean" (John Bale, Sons, & Danielsson, Ltd., London, 1936).
- Grettie, D. P., "Salad oil and method of making same," *U.S. Patent* 2,050,528, 1935.
- Griffiths, H. N., and Hilditch, T. P., "Oleic-elaidic acid transformation as an aid in the analysis of mixtures of oleic, linoleic, and linolenic acids," *J. Soc. Chem. Ind.*, vol. 53 (1935), p. 75T.
- Grove, Ernest W., "Soybeans in the United States; recent trends and present economic status," *U.S.D.A. Technical Bull.* 619, June, 1938.
- Hackleman, J. C., "La soja y sus multiples uses," *La Hacienda*, vol. 33, no. 1 (Jan., 1938), pp. 6-9, vol. 33, No. 2 (Feb., 1938), pp. 53-55.
- Hackleman, J. C., Sears, O. H., and Burlison, W. L., "Soybean Production in Illinois," *Ill. Agr. Expt. Sta. Bull.* 310, June, 1928.
- Hall, W., "Some analyses of commercial soybeans," *Paper presented before Paint and Varnish Division of Am. Chem. Soc.*, April 12-15, 1937.
- Hamilton, T. S., Uyei, N., Baker, J. B., and Grindley, H. S., "The quantitative determination of amino acids of feeds. II. The amino acids of linseed meal, wheat bran, soy

- beans and red clover hay," *J. Am. Chem. Soc.*, vol. 45 (1923), p. 815.
- Hanseatische Muhlenwerke, A. G., "Process for refining edible fats," *German Patent* 585,972. Cl. 53b, 1.03, 1933.
- Hanseatische Muhlenwerke, A. G., "Improvement in and relating to the treatment of natural butter," *British Patent* 406,696, 1934.
- Hansen, J., "Soybean cake," *Deut. Landw. Presse* 36, No. 41 (1909), pp. 439, 440, 453. (*Expt. Sta. Record*, vol. 21, p. 474.)
- Hauge, S. M., Wilbur, J. W., and Hilton, J. H., "An attempt to remove the vitamin A suppressing factor in soybean oil by adsorbents," (abstract) *J. Dairy Science*, vol. 20 (1937), p. 429.
- Hauge, S. M., Wilbur, J. W., and Hilton, J. H., "A further study of the factor in soybeans affecting the vitamin A value of butter," *J. Dairy Sci.*, vol. 20 (1937), p. 87.
- Hausman, Margaret J., "Soybean Oil," *Soap*, vol. 12 (Dec., 1936), p. 27.
- Hayden, C. C., and Perkins, A. E., "Soybeans and soybean oil meal for milk production," *Ohio Agr. Expt. Sta. Bi-Monthly Bull.*, vol. 11, no. 4 (July, 1926), pp. 137-41.
- Hayward, J. W., "Nutritive value of soybean oil meal prepared by the different methods of oil extraction," *Oil & Soap*, vol. 14 (1937), p. 317.
- Hayward, J. W., Steenbock, H., and Bohstedt, G., "The effect of heat as used in the extraction of soybean oil upon the nutritive value of the protein of soybean oil meal," *J. Nutrition*, vol. 11 (1936), p. 219.
- Hayward, J. W., Halpin, J. G., Holmes, C. E., Bohstedt, G., and Hart, E. B., "Soybean oil meal prepared at different temperatures as a feed for poultry," *Poultry Sci.*, vol. 16 (1937), p. 1.
- Hayward, J. W., Steenbock, H., and Bohstedt, G., "The

- effect of cystine and casein supplements upon the nutritive value of the protein of raw and heated soybeans," *J. Nutrition*, vol. 12 (1936), p. 275.
- Heiduschka, A., and Eger, H., "The composition of soybean oil of soja hispida," *Chem. Umschau Fette, Oele, Wachse Harze*, vol. 38 (1931), p. 129. (*Chem. Abs.*, vol. 25, 1931, col. 3860.)
- Hibbard, Aubrey D. P., "Photoperiodism and Enzyme Activity in the Soybean Plant," *Mo. Agr. Expt. Sta. Bull.* 271, Dec., 1937.
- Hilditch, T. P., and Pedelty, W. H., "The component fatty acids of the phosphatides of soy beans and rape seeds," *Biochem. J.*, vol. 31 (1937), p. 1964.
- Hilditch, T. P., and Jones, E. C., "Regularities in the glyceride structure of some technically important vegetable oils," *J. Soc. Chem. Ind.*, vol. 53 (1934), p. 19T.
- Hilton, J. H., Wilbur, J. W., and Epple, W. F., "Early, intermediate and late cut soybean hay for milk and butter-fat production," *Purdue University Agr. Expt. Sta. Bull.* 346, Feb., 1931.
- Hilton, J. H., Hauge, S. M., and Wilbur, J. W., "The vitamin A activity of butter produced by cows fed alfalfa hay and soybean hay cut in different stages of maturity," *J. Dairy Sci.*, vol. 18 (1935), p. 795.
- Hilton, J. H., Wilbur, J. W., and Hauge, S. M., "Ground soybeans and linseed oil meal for growing dairy calves," *Purdue Univ. Agr. Expt. Sta. Bull.* 354, 1931.
- Holdaway, C. W., Ellett, W. B., and Harris, W. G., "The comparative value of peanut meal, cottonseed meal and soybean meal as sources of protein for milk production," *Va. Agr. Expt. Sta. Tech. Bull.* 28, 1925.
- Horn, V., and Muhl, E., "Effect of soya beans before and after fat extraction on milk production and butter quality," *Biedermanns Zentralbl. (B) Tierernahrung*, 1937,

- 9, pp. 1-31. (Abstracted in *Nutr. Abs. & Rev.*, vol. 7, 1937, p. 222.)
- Hunt, R. E., "Wintering dairy heifers," *Va. Agr. Expt. Sta. Bull.*, 1921, p. 225.
- Hunter, J. E., Marble, D. R., and Knandel, H. C., "Vegetable protein in turkey rations," *Pa. State College, Agr. Expt. Sta. Bull.* 321, 1935.
- Iwanowa, N., "Nutritional value of the soya bean," *Problems of nutrition*, Moscow, vol. 4 (1935), p. 134. (*Nutr. Abs. and Rev.*, vol. 5, no. 3, p. 615.)
- Jamieson, G. S., Baughman, W. F., and McKinney, R. S., "Oil content of nine varieties of soybean and the characteristics of the extracted oils," *J. Agr. Res.*, vol. 46 (1933), p. 57.
- Jenkins, E. H., "Soybeans," *Conn. Agr. Expt. Sta. Bull.* 179, Oct., 1913.
- Johns, C. O., and Finks, A. J., "The nutritive value of soybean flour as a supplement to wheat flour," *Am. J. Physiol.*, vol. 55 (1921), p. 455.
- Jones, D. B., and Csonka, F. A., "Precipitation of soy bean proteins at various concentrations of ammonium sulfate," *Amer. Soc. Biol. Chem. Proc.*, vol. 26 (1932), p. 29.
- Jones, D. B., and Gersdorff, C. E. F., "Changes that occur in the proteins of soybean meal as a result of storage," *J. Am. Chem. Soc.*, vol. 60 (1938), p. 723.
- Jordon, S., "Food product and method of producing the same," *U.S. Patent* 1,859,240, 1932. "Flavoring material and method of using same," *U.S. Patent* 2,019,494, 1935.
- Kammlade, W. G., and Mackey, A. K., "The soybean crop for fattening western lambs," *Univ. of Ill. Agr. Expt. Sta. Bull.* 260.
- Kaufmann, H. P., "Studien auf dem Fettgebiet," *Verlag Chemie, G. M. B. H. Berlin*, 1935, p. 140.

- Kaufmann, H. P., "*Allgem. Ol-Fette Stg.*," vol. 27 (1930), p. 325.
- Kempster, H. L., "The influence of various protein concentrates on egg production," *Mo. Agr. Expt. Sta. Bull.* 288, 1930.
- Kiesselbach, T. A., and Lyness, W. E., "Soybeans in Nebraska," *Nebr. Agr. Expt. Sta. Bull.* 322, Oct., 1939.
- Kimura, Wasaburo, "Application of the thiocyanate number IV. Analysis of soybean oil," *Journal Soc. Chem. Ind.*, Japan, vol. 33, Suppl. binding, 1930, p. 325. (*Chem. Abs.*, vol. 25, 1931, col. 428.)
- Kishlar, L., "Some nutritive developments in soybean products," *Oil and Soap*, vol. 14 (1937), p. 237.
- Knug, L. C., and Fang, N. Y., "A preliminary report on the nitrogen metabolism of preschool children," *Chin. J. Physiol.*, vol. 9 (1935), p. 375. (*Expt. Station Record*, vol. 76, 1937, p. 273.)
- Kon, S. K., and Markuze, Z., "The biological values of the proteins of breads baked from rye and wheat flours alone or combined with yeast or soya bean flour," *Biochem. J.*, vol. 25 (1931), p. 1476.
- Kraybill, H. R., Smith, R. L., and Walter, E. D., "The isolation of sucrose from soybeans," *J. Am. Chem. Soc.*, vol. 59 (1937), p. 2470.
- Laucks, I. F., and Davidson, Glenn, "Paper in symposium on: Glues for wood products," *6th An. Wood. Indus. meeting*, Winston-Salem, N.C., 1931.
- Lederer, E. L., "Changes in the properties of soap by adding lecithin," *Siefensieder Ztg.*, vol. 60 (1933), p. 919. (*Chem. Abs.*, vol. 28, 1934, col. 2209.)
- Levine, H., and Remington, R. E., "The vitamin G content of some foods," *J. Nutrition*, vol. 13 (1937), p. 525.
- Linsey, J. B., Holland, E. B., and Smith, P. H., "Effect of soy-

- bean meal and soybean oil upon the composition of milk and butter fat and upon the consistency or body of butter," *Mass. Agr. Expt. Sta. Twenty-first An. Report, Part II*, 1909, pp. 66-110.
- Lloyd, J. W., and Burlison, W. L., "Eighteen varieties of edible soybeans," *Ill. Agr. Expt. Sta. Bull.* 453, Mar.,
- Markley, K. S., "Table by K. S. Markley," *U.S. Regional Soybean Industrial Products Laboratory*, Urbana, Ill.
- Mashino, M., "Studies on the soya-bean proteins," *J. Soc. Chem. Ind.*, vol. 54 (1935), p. 236T.
- Megee, C. R., "Soybeans," *Mich. Agr. Expt. Sta. Spec. Bull.* No. 100, Mar., 1920.
- Megee, C. R., "Soybean production in Michigan," *Mich. Agr. Expt. Sta., Cir. Bull.* 161, June, 1937.
- Meisel, E., and Bocker, F., "Sur les constituents de la grain de soja," *Monatschefte fur Chemie IV*, 1883, p. 349.
- Metzger, J. E., Holmes, M. G., and Bierman, Harlow, "Soybeans—Production, Composition and Feeding Value," *Maryland Agri. Expt. Sta. Bull.* 277, Oct., 1925.
- Mitchell, H. H., and Villegas, V., "The nutritive value of the proteins of coconut meal, soybeans, rice bran and corn," *J. Dairy Sci.*, vol. 6 (1923), p. 222.
- Mitchell, H. H., and Smuts, D. B., "The amino acid deficiencies of beef, wheat, corn, oats, and soybeans for growth in the white rat," *J. Biol. Chem.*, vol. 95 (1932), p. 263.
- Moore, J. S., and Cowsert, W. C., "Soybeans for dairy cows," *Miss. Agr. Expt. Sta. Bull.* 235, 1926.
- Morrison, F. B., "Feeds and feeding" (Morrison Publishing Co., 20th ed., 1936), p. 988.
- Morse, W. J., "Soybeans in the cotton belt" (Government Printing Office, 1915).
- Morse, W. J., "Soybeans now a major crop in U.S.; few grown before 1898," *U.S.D.A. Yearbook*, 1933, p. 198.

- Morse, W. J., "Soybean variety studies of the United States Department of Agriculture," *Proc. American Soybean Assn.*, 1937.
- Morse, W. J., "The soy bean: its culture and uses," *U.S.D.A. Farmers' Bull.* 973, July, 1918.
- Morse, W. J., "Soybeans: culture and varieties," *U.S.D.A. Farmers' Bull.* 1520, April, 1927.
- Morse, W. J., "Soybean hay and seed production," *U.S.D.A. Farmers' Bull.* 1605, Oct., 1929.
- Morse, W. J., "Soybean utilization," *U.S.D.A. Farmers' Bull.* 1617, Jan., 1930.
- Morse, W. J., "Early Chinese disagreed on planting time, modern problem troubled early experts too, reviews of ancient Chinese agricultural literature reveal," *Soybean Digest*, vol. 1, no. 5 (March, 1941), p. 5.
- McCandlish, A. C., and Weaver, E., "Coconut meal, gluten feed, peanut meal and soybean meal as protein supplements for dairy cows," *J. Dairy Sci.*, vol. 5 (1922), p. 27.
- McCandlish, A. C., Weaver, Earl, and Lunde, L. A., "Soybeans as a home grown supplement for dairy cows," *Iowa Agr. Expt. Sta. Bull.* 204, 1922.
- McClelland, C. K., "Methods and rates of planting soy beans," *Ark. Agri. Expt. Sta. Bull.* 390, June, 1940.
- McClelland, C. K., "Soybean varieties for hay, seed, and oil production," *Ark. Agr. Expt. Sta. Bull.* 334, 1936. (*Chem. Abs.*, vol. 31, p. 896.)
- McCollum, E. V., Simmonds, N., and Parsons, H. T., "Supplementary relations of the proteins of milk for those of cereals and of milk for those of legume seeds," *J. Biol. Chem.*, vol. 47 (1921), p. 235.
- McKinney, R. S., Jamieson, G. S., and Holton, W. B., "Soybean phosphatides," *Oil and Soap*, vol. 14 (1937), p. 126.
- Nevens, W. B., "Making best use of soybeans in feeding dairy cattle," *Univ. of Ill. Expt. Sta. Circ.* 369, 1931, p. 5.

- Nevens, W. B., and Tracy, P. H., "The relation of soybean hay and ground soybeans to flavor and composition of milk and butter," *J. Dairy Sci.*, vol. 11 (1928), p. 479.
- Noll, C. F., and Lewis, R. D., "Soybeans," *Pa. State Agr. Expt. Sta. Bull.* 167, April, 1921.
- Noll, C. F., and Lewis, R. D., "Soybeans: their culture and uses," *Pa. Agr. Expt. Sta. Bull.* 187, April, 1924.
- Nollau, E. H., "The amino acid content of certain commercial feeding stuffs and other sources of protein," *J. Biol. Chem.*, vol. 21 (1915), p. 611.
- Norris, L. C., Wilgus, Jr., H. S., Ringrose, A. T., Heinman, V., and Heuser, G. F., "The vitamin-G requirement of poultry," *Cornell Expt. Sta. Bull.* 660, 1936.
- Nottbohm, F. E., and Mayer, F., "Differentiation of lecithin preparations of animal and plant origin," *Chem-Ztg.*, vol. 56 (1932), p. 881.
- O'Brien, W. J., "Soybean proteins," *Proc. Second Dearborn Conf. of Agr., Ind., & Sci.*, May, 1936, p. 254.
- O'Kelley, J. F., and Gieger, M., "Effect of variety, maturity, and soundness on certain soybean seed and oil characteristics," *Miss. Agr. Expt. Sta. Technical Bull.* 24, 1937.
- Olcott, H. S., and Mattill, H. A., "Antioxidants and the anti-oxidation of fats. IV. Lecithin as an antioxidant," *Oil and Soap*, vol. 13 (April, 1936), p. 98.
- Olson, T. M., "Soybeans for dairy cows," *Agr. Expt. Sta. Bull.* 215, 1925.
- Osborne, T. B., and Campbell, G. F., "Proteids of the soybean (*Glycine hispida*)," *J. Am. Chem. Soc.*, vol. 20 (1898), p. 419.
- Osborne, T. B., and Clapp, S. H., "Hydrolysis of glycinin from the soybean," *Amer. J. Physiol.*, vol. 19 (1907), p. 468.
- Osborne, T. B., and Mendel, L. B., "The use of soybean as food," *J. Biol. Chem.*, vol. 32 (1917), p. 269.

- Otis, D. H., "Experiments with dairy cows," *Kan. Agr. Expt. Sta. Bull.* 125, 1904.
- Philips, A. G., and Hauge, S. M., "Soybean oil meal in rations for laying pullets," *Purdue Agr. Expt. Sta. Bull.* 293, 1925.
- Phillips, J. B., "Utilization of the soybean," *Soc. Chem. Ind., J.*, vol. 53 (1934), p. 627.
- Piper, C. V., and Morse, W. J., "The Soybean" (McGraw-Hill Book Co., 1923), p. 205.
- Piper, C. V., "How we got our soybeans," *Paper before the 6th Annual Field Meeting of the American Soybean Association*, Washington, D.C., Sept. 1-3, 1925, p. 58.
- Piper, C. V., and Morse, W. J., "The soybean, with special reference to its utilization for oil, cake, and other products," *U.S.D.A. Bull.* 439, 1936.
- Poehlman, J. M., "A study of the relative adaptation of certain varieties of soybeans," *Mo. Agr. Expt. Sta. Research Bull.* 255, May 12, 1937.
- Post, A. H., "Soybeans: Their adaptation and production in Montana," *Mont. Agr. Expt. Sta. Bull. No.* 335, Feb., 1937.
- Price, J. N., "Home-grown rations in economical production of milk and butter," *Tenn. Agr. Expt. Sta. Bull.* 80, 1913.
- Ralston Purina Co., Special report on Purina core oil. St. Louis, Mo., 1932.
- Rewald, B., "Chemical, physical and colloidal properties of lecithin," *J. Intern. Soc. Leather Trades Chem.*, vol. 19 (1935), p.
- Rewald, B., "Light colored mixture of vegetable phosphatides and fatty oil," *U.S. Patent* 1,895,424, 1933.
- Rewald, B., "Method of separating fatty constituents from oleaginous materials," *U.S. Patent* 1,903,397, 1934.
- Rewald, B., "Process for the production of rubber mixtures," *U.S. Patent* 1,946,333, 1934.

## SOYBEANS

- Robison, W. L., "Soybeans and soybean oil meal for pigs," *Ohio Agr. Expt. Sta. Bull.* 452, 1930.
- Ross, R. C., "Soybean costs and production practices," *Ill. Agr. Expt. Sta. Bull.* 428, Dec. 1936.
- Rusk, H. P., Nevens, W. B., Kammlade, W. G., Edmonds, J. L., Crawford, C. W., Carroll, W. D., and Sloan, H. J., "Utilizing the Soybean Crop in Livestock Feeding," *Ill. Agr. Expt. Sta. Circular* 369, April, 1931.
- Sato, M., and Yokochi, M., "Experiments on the extraction of soy bean oil with alcohol," *Abst. Rep. Central Lab., Dairen (Manchuria)*, 1929, p. 3.
- Satow, Sadakichi, "Researches on oil and proteid extraction from soy bean," *Technology Reports of the Tokoku Imperial University*, Sendai, Japan, vol. 2 (1921), p. 83.
- Savage, E. S., "Some recent developments in the feeding of dairy calves," *A Progress Report from Cornell University*.
- Schaefer, O. G., "Soybeans and soybean hay in the dairy ration," *Minn. Agr. Expt. Sta. Bull.* 239, 1927.
- Scheunert, A., and Schieblich, M., "Vitamin content of fresh soya-beans," *Biedermans Zentralble. B. Tierernahrung.*, vol. 7 (1935), p. 198. (*Nutr. Abs. & Rev.*, vol. 5, p. 343.)
- Sears, O. H., "Soybeans: Their effect on soil productivity," *Ill. Agr. Expt. Sta. Bull.* 456, June, 1939.
- Sheehy, E. J., "The effect of dietary fat on the fat content of cow's milk," *Conference Papers, 1st Section, The International Dairy Congress, English Edition*, 1931, p. 76.
- Shinozaki, Y., and Sato, M., "Soy lecithin. II. The hydrogenation under high pressure," *J. Soc. Chem. Ind., Japan*, vol. 37 (1934), p. 432. (*Chem. Abs.*, vol. 28, 1934, col. 7566.)
- Shoptaw, La Van, "Soybean flour as a substitute for cow's milk in feeding dairy calves," *J. Dairy Sci.*, vol. 19 (1936), p. 95.

- Shrewsbury, C. L., and Bratzler, J. W., "Cystine deficiency of soy bean protein at various levels, in a purified ration and as a supplement to corn," *J. Agr. Res.*, vol. 47 (1933), p. 889.
- Shrewsbury, C. L., Vestal, C. M., and Hauge, S. M., "The effect of yeast and casein supplements to corn and soy bean rations when fed to rats and swine," *J. Agr. Res.*, vol. 44 (1932), p. 267.
- Skinner, J. H., and King, F. G., "Winter steer feeding," *Purdue Univ. Agr. Expt. Sta. Bull.* 314, part 1, p. 8.
- Sloan, H. J., "Soybeans for poultry," *Ill. Expt. Sta. Circ.* 369, 1934, p. 42.
- Smith, C. D., and Robison, F. W., "Influence of nodules on the roots upon the composition of soybeans and cowpeas," *Mich. Agr. Expt. Sta. Bull.* 224, 1905.
- Smith, W. B., "The composition of soy-bean oil," *Ind. & Eng. Chem.*, vol. 14 (1922), p. 530.
- Snapp, R. R., "Soybeans and soybean products for beef cattle and sheep," *Proceedings Am. Soybean Association*, 1937, p. 29.
- "Soybean possibilities to be studied," *Chem. and Met. Eng.*, vol. 43 (April, 1936), p. 211.
- "Soybeans," *Ala. Polytechnic Institute Agr. Expt. Sta. Leaflet* 2, July, 1934.
- "Soybeans; which may be glue, milk, cheese, sauce, varnish, axle grease, fertilizer, soap, soup, buttons, artificial leather, enamel," *Fortune*, vol. 1, no. 5 (June, 1930), pp. 102-104.
- Stewart, C. L., Burlison, W. L., Norton, L. J., and Whalin, O. L., "Supply and marketing of soybeans and soybean products," *Ill. Agr. Expt. Sta. Bull.* 386, 1932.
- Stock, E. "Influence of vegetable lecithins in the manufacture of paint," *Farben-Ztg.*, vol. 38 (1933), p. 905. (*Chem. Abs.*, vol. 27, 1933, col. 3348.)
- Street, J. P., and Bailey, E. M., "The carbohydrates and en-

- zymes of the soybean," *J. Ind. Eng. Chem.*, vol. 7 (1915), p. 853.
- "Survey of the American soya-bean oil industry," prepared by the *U.S. Tariff Commission* and printed for use of Committee on Ways and Means, Washington, 1920.
- Suzuki, B., and Nishimoto, U., "Cephalins of the soybean," *Proc. Imp. Acad.*, Japan, vol. 6 (1930), p. 262. (*Chem. Abs.*, vol. 24, 1930, col. 5305.)
- Suzuki, B., and Yokoyama, Y., "Soybean lecithin, I. The separation of alpha and beta series," *Proc. Imp. Acad.*, Japan, vol. 6 (1930), p. 341. (*Chem. Abs.*, vol. 25, 1931, col. 530.)
- Suzuki, U., "Occurrence of vitamin E in soy-bean oil," *Sci. Papers Inst. Phys. Chem. Research*, Tokyo, vol. 23 (1934), p. 270. (*Chem. Abs.*, vol. 28, col. 3449.)
- Tanret, Georges, "Sur la presence de stachyose dans le Haricot et les graines de quelques autres Legumineuses," *Bull. Soc. Chem.* 13, 1913, p. 176.
- Taylor, R. L., "How soybeans help build Fords," *Chem. and Met. Eng.*, vol. 43 (April, 1936), p. 172.
- Thompson, Firman, and Morgan, H. H., "Soy bean oil," *Del. Agri. Expt. Sta. Bull. No. 98*, Dec. 1, 1912.
- Tomhave, A. E., "Soybean meal and ground soybeans as protein supplements for dairy cattle," *Del. Agr. Expt. Sta. Bull.* 148, 1927.
- Tomhave, A. E., and Mumford, C. W., "Ground soybeans as a protein supplement for growing chicks," *Del. Agr. Expt. Sta. Bull.* 183, 1933.
- Tomhave, A. E., and Mumford, C. W., "Ground soybeans as a protein supplement for growing chicks," *Del. Agr. Expt. Sta. Bull.* 197, 1936.
- Turk, K. L., Morrison, F. B., and Maynard, L. A., "The nutritive value of the proteins of corn-gluten meal, linseed meal and soybean-oil meal," *J. Agr. Res.*, vol. 51, p. 401.

- Uhland, R. E., "Time of harvesting soybeans. In relation to soil improvement and protein content of the hay," *Mo. Agr. Expt. Sta. Bull.* 279, Feb., 1930.
- "Utilization of soybeans, abstracts of papers before American Chemical Society," *Chem. Age* (London), vol. 34 (May 9, 1936), pp. 417-18.
- Vestal, C. M., and Shrewsbury, C. L., "The effect of soybeans, soybean oil meal and tankage on the quality of pork," *Purdue Univ. Agr. Expt. Sta. Bull.* 400, 1935.
- Vestal, C. M., and Shrewsbury, C. L., "The nutritive value of soybeans with preliminary observations on the quality of pork produced," *Am. Soc. An. Prod. Proc.*, 1932, p. 127.
- Wahl, A. S., "The new method of increasing body in beer," *Brewery Management and Engineering*, Aug., 1933.
- Ware, E. E., "The role of soybean oil in paint formulation," *Proc. Second Dearborn Conf. of Agr. Ind., and Sci.*, 1936, p. 250.
- Ware, E. E., "Soybean oil and the paint industry," *Ind. Eng. Chem.* vol. 28 (1936), pp. 903-6. (*Chem. Abs.*, vol. 30, p. 6218.)
- Watts, Betty M., "Whipping ability of soybean protein," *Ind. and Eng. Chem.*, vol. 29 (1937), p. 1009.
- Webster, J. E., and Kiltz, B. F., "Oil and protein studies of Oklahoma grown soybeans," *Proc. of the Okla. Academy of Science*, vol. 15 (1935), p. 32.
- Wieschahn, G. A., "Soy bean phosphatides and their uses," *Oil and Soap*, vol. 14 (1937), p. 119.
- Wiggans, R. G., "Cayuga Soybean: A homegrown, high-oil, high-protein concentrate," *Cornell University Agri. Expt. Sta., Ithaca, N.Y., Bull.* 601, May, 1934.
- Wilbur, J. W., Hilton, J. H., and Hauge, S. M., "The effect of soybeans in the rations of dairy cows upon the vita-

- min A value of butter," *J. Dairy Sci.*, vol. 18 (1935), p. 661.
- Wilgus, H. S., Jr., Norris, L. C., and Heuser, G. F., "Effect of heat on nutritive value of soy-bean oil meal," *Ind. and Eng. Chem.*, vol. 28 (1936), p. 586.
- Wilgus, H. S., Jr., Norris, L. C., and Heuser, G. F., "The relative protein efficiency and the relative vitamin G content of common protein supplements used in poultry rations," *J. Agr. Research*, vol. 51 (1935), p. 383.
- Williams, N. K., Cannon, C. Y., and Espe, D. L., "Production of dairy cows when fed only silage and cracked soybeans," *J. Dairy Sci.*, vol. 19 (1936), p. 459.
- Woodruff, Sybil, "Edible varieties of soybeans," *Proc. American Soybean Association*, 1937.
- Woodworth, C. M., "Illini soybeans," *Ill. Agr. Expt. Sta. Bull.* 335.
- Woodworth, C. M., "Genetics and breeding in the improvement of the soybean," *Ill. Agr. Expt. Sta. Bull.* 384, Nov., 1932.
- Working, E. B., "Chocolate material and method of making same," *U.S. Patent* 1,781,672, 1930.
- Working, E. B., "Shortening composition and method," *U.S. Patent* 1,831,728, 1931.
- York, H. A., "Soybeans in the Yazoo-Mississippi Delta," *Miss. Expt. Sta. Bull.* 331, June, 1939.
- Zahnley, J. W., "Soybean production in Kansas," *Kans. Agr. Expt. Sta. Bull.* 282, March, 1939.

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